ELEMENTS OF HYGIENE AND SANITATION

HOUGH AND SEDGWICK

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BEING PART II OF "THE HUMAN MECHANISM: ITS PHYSIOLOGY AND HYGIENE AND THE SANITATION OF ITS SURROUNDINGS"

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PREFACE TO THE REVISED EDITION

This edition presents a thorough revision in which the authors have incorporated those advances in hygiene and sanitation which are directly applicable to the fundamental purpose of the book as explained in the preface to the first edition. In several chapters, notably that on communicable diseases, additions have been made to the original text and two new chapters have been added. One of these deals with the hygiene of the mouth, nose, and throat and with focal infections in general, the structure and care of the teeth having been transferred from Part I and included in this chapter; the other deals with those communicable diseases conveyed by insects. Advantage has also been taken of the opportunity offered by the reprinting of the entire work to make many changes in the interest of greater simplicity or clearness of presentation.

We are indebted to Dr. J. S. Ferguson for permission to use the figure of the lingual tonsil on page 404.

PREFACE

The present volume is a reprint of the second and concluding portion of our larger work entitled *The Human Mechanism*, of which the first part is devoted to physiology. For the use of students who have already had courses in physiology in which insufficient attention was paid to hygiene and sanitation, for the general reader, and for all who desire an elementary introduction to the principles and practice of hygiene and sanitation, this volume should prove useful.

The authors hold with Matthew Arnold that "conduct is three fourths of life," and that this is no less true of the physical than of the moral and the intellectual life. They therefore make no apology for fixing upon conduct as the keynote of the present work, and *the right conduct of the physical life* as the principal aim and end of all elementary teaching of hygiene and sanitation.

In those portions of the volume devoted to public hygiene and sanitation the authors have kept in view the importance of these subjects in education for good citizenship. Sanitary science and the public health can be advanced only as they are supported by an intelligent public opinion which appreciates the nature of the problems involved, the frequent duty of subordinating personal liberty to the public good, and the importance of rendering hearty support to public officials in the discharge of difficult and often delicate tasks.

Personal hygiene is nothing more nor less than the application of physiology to the actual conduct of life, and its principles can be mastered only when their study is preceded by that of the elements of physiology. In the hope that many who read this volume may be led to make a careful study of the scientific basis of hygienic conduct, Part I of *The Human Mechanism* has also been issued separately under the title, "Elements of Physiology."

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[For convenience of reference, both to the complete work and to each of its separately published parts, the page and chapter numbers of "The Human Mechanism" are retained.]

PUBLIC HYGIENE AND SANITATION

THE HUMAN MECHANISM

PART II

THE HYGIENE OF THE HUMAN MECHANISM AND THE SANITATION OF ITS SURROUNDINGS

PART II

CHAPTER XVI

INTRODUCTORY

1. Hygiene and sanitation: the right use and proper care of the human mechanism. The owner of a valuable lifeless mechanism, such as a watch or a piano, pays attention to its proper care and operation. So also does the owner of a valuable living mechanism, such as a prize-winning dog, or horse, or cow. Yet men and women, owners of far more precious mechanisms than any of these, namely, human bodies, often neglect and sometimes abuse the invaluable machine committed to their care. Sometimes, it is true, the human body seems able to endure neglect and even overcome abuse, for it has wonderful powers of recuperation and recovery; but at other times we know that only constant care and favorable surroundings suffice to keep it alive.

It is encouraging to observe that much of the best work of the world has come from persons in poor health. Darwin never enjoyed robust health; Heine was an invalid in his later years; Milton was blind; Sir Walter Scott was lame; Pasteur was partially paralyzed during his later life. On the other hand many, originally robust, have not only broken down and failed to do good work for themselves and their fellows but have become a burden to the world because they have refused to give to their bodies that care which they would freely bestow on a watch or an automobile.

The proper management and operation of the human mechanism requires not only care, but *intelligent* care.

A locomotive is intrusted only to an engineer who knows its construction, who can detect the evidences that something is wrong, who knows how much steam to apply at different times, what to do on various grades, how to start his engine safely, and how to bring it to rest. In Part I we have endeavored, by lessons on anatomy and physiology, to impart to the student the same preliminary knowledge of the construction and workings of the human mechanism which anyone intending to be an engineer must have of machinery before he can master the practical operation of his engine. The chapters immediately following are concerned with the proper care and management of the mechanism under the various conditions of daily life.

The principles governing the proper care and right use of the human mechanism and its surroundings form the subject matter of *hygiene* and *sanitation*; and practical hygiene and sanitation consist in the application of the principles of physiology and sanitary science to the conduct of physical life. Their object is the preservation and promotion of health, the prevention of premature death, and the establishment and maintenance of the highest possible working efficiency of the human mechanism.

2. Different attitudes assumed toward health and disease. *Health is a condition* of the human mechanism in which all important parts are sound and in good working order. Such a mechanism does its work without pain and with ease; but when it becomes unsound or abnormal, pain and disease eventually appear, as in a toothache, a sore throat, a "racking" cough, a "splitting" headache, or uneasiness of the stomach in dyspepsia. *Disease is also a condition*, but one in which one or more of the organs is unsound or abnormal or in such poor working order as to interfere seriously with the welfare of the entire mechanism.

Various attitudes are assumed by different persons towards health and disease. *One attitude*, represented perhaps by the practice of the majority of people, is to go about one's work, whatever that may be, giving no thought whatever either to the maintenance of health or to the avoidance of disease; in other words, to pay no attention to the mechanism and to do nothing to keep it in order; to wait until something happens, some breakdown occurs, some disease has clearly developed, and then hastily to take a dose of medicine or, finally, to call a physician. This we may call the attitude of *heedlessness.*

A second attitude is that of neglecting any active cultivation of health, but carefully attempting to avoid those things which are liable to produce disease. In this case persons often give great attention to the choice of diet, to protection against cold, to the purity of their drinking water, their food supplies, etc., fixing their attention wholly on the agents of disease and assuming that, if these be kept at a distance, the body will take care of itself. This may be called a *half-hygienic* attitude.

A third attitude — the reverse of the second — consists in actively cultivating abounding health by attention to those things which are believed to build up a strong constitution, in the belief that no disease can attack a strong and vigorous body. Such persons concentrate attention on health and underestimate the possibilities of succumbing to attacks of disease. This also is a *half-hygienic* attitude, although in practice perhaps somewhat safer than the second; very many, perhaps all, diseases are less likely to appear in a strong and vigorous body than in one which is not in sound health. But if the experience of the race teaches anything, it is that strong men, seemingly in perfect health, often succumb to attacks of disease. It is not safe, even for a healthy man, to swallow the germs of Asiatic cholera; it is not safe, even for a healthy man, to prick his finger with a knife which has been used in lancing a boil. Without in the least undervaluing the importance of maintaining health and physical vigor as preventives of disease, we cannot too strongly affirm that these are not absolute preventives, that they are not reliable preventives, and that in some cases they are not preventives[1] at all.

A fourth (and the only right) attitude toward health and disease is that which actively seeks to maintain in the mechanism the highest possible degree of health under all conditions and at the same time constantly takes all reasonable precautions to ward off attacks of the external agents of disease. This is the true hygienic attitude, as indicated by reason and modern science; and this attitude of mind we shall endeavor in the following pages to encourage, justify, and strengthen in students or readers of this work.

3. The three great factors of disease. Keeping always in mind the truth that the human body is a machine or mechanism, and agreeing to regard any condition as one of disease in which the body does not do its work smoothly or with ease, we perceive that there are three great causes of disease of the body, just as there are three chief causes of trouble in the running of a locomotive. These are (1) imperfections in the mechanism itself; (2) unskillful operation and care; and (3) unfavorable external conditions. Let us consider carefully the part played by each of these in the maintenance of health and the prevention of disease.

1. *Imperfections in the mechanism.* The wheels of an engine may not be perfectly true, some of its valves may leak, some bearing may be unduly exposed to dust. So is

[1] The truth of this fact is illustrated when there appears among a people some disease to which neither they nor their ancestors have regularly been exposed — the ravages of epidemics of Asiatic cholera in Europe and America, and the history of the great plague in Europe in the seventeenth century, or of yellow fever in our own southern states, being cases in point (see Daniel Defoe, *Journal of the Plague Year*; James Ford Rhodes, *History of the United States*, I, 400). The North American Indians, who were presumably strong and healthy, were decimated by measles — a comparatively mild disease — when this was brought among them by the early settlers of this country.

it with the human body. Wonderful as is the human mechanism, it is never perfect. A valve in the heart may leak and permit "regurgitation" of the blood; a defect in the structure of the spine may make it hard to hold the trunk in its normal posture; the glands of the stomach or pancreas may be made of poor material and so secrete an ineffective digestive juice; in short, any organ may be of poor construction and so have imperfect capacity for work. Such constitutional defects may be born with us, or they may be acquired by some accident or other circumstance which leads to irreparable and permanent injury. Where they exist they must be recognized and reckoned with in what we attempt to do, although their cure or compensation is by no means hopeless. The deaf mute adapts himself to a lack of hearing and in spite of it communicates with his fellows; and men and women with serious organic troubles may often lead useful and, on the whole, healthy lives.

Again, every human body possesses as the outcome of its construction or constitution more or less capacity to endure hardship and to struggle for continued existence. In the strong this capacity, loosely called *vital resistance*, may be very great, and in the weak or feeble very small, but in order that life shall continue at all, every human body must have more or less of it. It is required to withstand heat and cold, underfeeding and overfeeding, the attacks of parasites, the work and the play of life, the infirmities of age. If it be very great, almost all hardships can be endured, almost all diseases avoided or overcome; if it be very small, as it often is in old age, even the grasshopper may become a burden.

As we pass middle life and old age creeps over us we find this power of vital resistance lessened. Of all people who enter their seventieth year, a much larger percentage die before reaching their next birthday than is the case with those entering their twentieth year. This can only mean that the ability to cope with unfavorable conditions is lessened as age advances. The body shows by growing feebleness that it is wearing out, and ultimately succumbs to disease which in earlier life would have been a matter of small consequence. Hence it follows that old people must reckon with a poorer constitution and must give greater care than the young to the bodily machine.

2. *Unskillful operation and care.* The most perfect engine will behave badly in the hands of an ignorant, unskillful engineer or fireman. There is a proper method of firing, a proper method of starting; and when a grade is to be ascended it must be taken in the proper way. When these things are not done rightly, the engine is very apt to suffer damage, even to acquire structural or constitutional defects; and in no such case can it be expected to do its best work, or to do any work, with perfect ease. Human life involves the operation of a much more delicate engine or mechanism. The human body is a machine calculated to do work, and when we say that it is alive, we mean that it makes use of the potential energy of foods to accomplish ends which no lifeless machine can accomplish; but it does not do this life work without management or operation. It is the faithful servant of an intelligent will, and it may be worked or used wisely or unwisely, skillfully or unskillfully. This engineering, management, direction, or operation of the human mechanism constitutes the *physical conduct of life* and is one of the most fundamental and important elements in the maintenance of health.

3. *Unfavorable external conditions.* Again, the best work of an engine requires more than good construction and skillful operation; it also requires favorable conditions and surroundings. If the roadbed be poorly ballasted or the rails rusty and uneven, if the weather be so cold as to make it impossible to keep up full steam in the boiler, if the water tanks be not kept supplied with water or the coaling stations with

fuel, then poor work and often actual injury to the mechanism itself — constitutional injury — is the result. Finally, if by chance a stone has rolled upon the track, or a signal has been wrongly set and a collision results, a good locomotive may be disabled or even ruined.

So with the human mechanism. Like all other living things it cannot continue its work under certain external conditions. It cannot live without food in a desert; it cannot endure exposure to extreme cold without protection; it cannot keep sound in a room with leaky gas fixtures or in a cell which admits no sunshine. It must have proper drink and proper food, and it must avoid exposure to the contagion of diseases against which it has no sure defense.

4. Scope and subdivisions of hygiene and sanitation. The considerations dwelt upon in the foregoing pages indicate the scope and possibilities of the science of hygiene. Given the constitution of any individual as it is at any one time, we must seek to maintain or place that constitution in a condition of health, or efficient working order, in two ways: first, *by the proper care and operation of the mechanism itself*, including the proper direction of its activities; and second, *by providing for it favorable surroundings or environment.* The former we call *hygiene*, the latter *sanitation.* Each of these efforts reacts on the constitution; improper operation of the muscles in muscular work or improper use of the nervous system in mental work may "undermine" a strong constitution and lower its vital resistance; similarly, a bad climate, a neglect of the ventilation of living and sleeping rooms, the use of polluted water or milk or other food, exposure to the contagion of disease or to excessive cold without proper clothing, — all such failures to provide a proper environment may injuriously affect the constitution or structure of the body.

It is impossible to draw any sharp line between the care, management, and operation of the body mechanism and the care and control of the environment, and it is neither necessary nor desirable to do so; but we shall begin our detailed study with those things which concern chiefly the care, use, and operation of the mechanism itself — such, for example, as the proper direction of muscular and nervous activity; alimentation or right feeding; the use and abuse of stimulants, narcotics, and other drugs; bathing, clothing, the care of the eyes and ears, etc. These matters which concern chiefly the individual or the person constitute that part of our subject known as *personal hygiene.*

We shall then proceed to consider those matters of health which concern not only individuals but communities of individuals, such as families, cities, states, and nations: for example, the site, ventilation, heating, and plumbing of the dwelling house; the control of food supplies, as to their purity; public supplies of water and milk; sewage disposal; the infectious and contagious diseases. All these things require the coöperation of many individuals, either as families or as citizens of an entire town, city, or nation. Hence they are classed under *domestic hygiene and sanitation* and *public hygiene and sanitation.*

PERSONAL HYGIENE

CHAPTER XVII

MUSCULAR ACTIVITY

A. The Ministry of Muscular Activity to the Body as a Whole

We know that it is through muscular activity that we do many necessary, useful, or otherwise desirable things, and also that muscular activity is required in order to build up strong muscles. But the effects of muscular activity on the body as a whole are not so obvious. A large number of people think that it is "a good thing," and a smaller number are convinced that it is absolutely necessary to the best of health; yet we not infrequently hear men and women seriously question the latter proposition and even venture to doubt the truth of the former.

Now there is nothing in hygiene more clearly established than that muscular activity is essential to healthy living. The effects of a sedentary life may not show themselves at once, but almost without exception they will assert themselves in the end. Muscular work, in other words, not only enables us to influence our surroundings, not only builds up strong muscles, but in other and equally important though often unseen ways *ministers to the health of the body as a whole.*

1. The present use of the term "muscular activity." In the present chapter the term "muscular activity" is used in a somewhat general sense and without attempting to set sharp limitations upon it. Strictly speaking, of course, muscular activity would include all work done by the muscles of the body, and this is of various kinds. Even those persons who do no manual labor unconsciously perform muscular work; the heart works on, the breath comes and goes through orderly muscular contractions; sitting and standing, speech, gestures, mastication, — all these involve muscular activity and do, as a matter of fact, contribute something to the maintenance of the healthful conditions of the body. It is not improbable that they are the physical salvation of thousands of people leading sedentary lives. At the other extreme are those who perform severe manual labor or who engage in vigorous exercises or purposely cultivate exceptional physical strength.

We are not, however, directly concerned at present with either of these extremes nor with those forms of muscular activity so common to-day in workshops, where, hour after hour, the workman performs the same task over and over again. We are concerned rather with those forms of muscular work which are seen in a lumber camp or on the farm; which present the characteristic of variety and involve the use of the musculature of the body as a whole; in short, those forms of activity by which until very recently the human race has supported itself in its daily life. Such things as brisk walking, running, rowing, wood chopping, swimming, tennis playing, would thus be placed in the same class, since they involve a use of the muscles similar to those which we have mentioned.

2. How does general muscular activity contribute to health? The physiological effects of muscular activity. In the case of many measures which minister to health, it is comparatively easy to see what each contributes; thus, clothing protects from undue loss of heat; proper feeding facilitates the subsequent performance of the digestive processes; right habits with regard to sleep and rest remove the harmful effects of fatigue and insure restoration of working power. In the case of muscular activity, on the other hand, we are dealing with something which involves loss of stored power together with the production of fatigue or waste products; and at first thought it may seem strange that the body as a whole should derive benefit from an activity which produces such results.

To understand this apparent paradox we must learn what are the results (that is, the physiological effects) of muscular activity and determine how each of these may contribute to health. The more important results are the following:

1. *Marked physical and chemical changes in the working organs (muscles), which changes are far greater than those which accompany any other bodily activity.* The output of carbon dioxide by the body per minute is increased at once from three- to ten-fold with what would be termed moderate or vigorous exertion, while digestion seldom increases it more than one fifth, and mental work shows practically no effect upon it. Large quantities of heat are likewise liberated, and the temperature of the muscle rises several degrees. These physical and chemical changes are mentioned first because the hygienic effects upon the body as a whole are to be traced to them as the primary cause.

2. As the result of these changes in the muscles *new physical and chemical conditions are introduced into the blood and lymph.* The excess of carbon dioxide is entirely excreted by the lungs, so that the blood carried to the other organs by the arteries shows no increase in this substance; but other waste products (such as salts of lactic acid), whose elimination requires the coöperation of other organs than the lungs, are found in the arterial blood in larger quantities than during rest. The chemical and physical characteristics of the immediate environment of every cell of the body is thus changed, and profoundly changed. Let us now consider the reaction of other organs to these changes in the muscles and in the blood and lymph.

3. *Some of the most striking effects of muscular work are those which are connected with the heat-regulating mechanism.* The large liberation of heat by the working muscle necessitates active measures to get rid of that heat and maintain the constant temperature. The small arteries of the skin dilate, while those of internal organs constrict, perspiration is secreted, and all these processes are carried out in a coördinated manner. The nervous mechanism of heat regulation is given a new form of activity and thus receives valuable training in adjusting itself to the changing conditions with which it has to cope in daily life.

4. *Closely connected with the foregoing is the (temporary) relief afforded to any congestion of blood in the internal organs.* Sedentary occupations usually involve more or less overfilling of the blood vessels of the stomach and intestine, the pancreas, the liver, the spleen, and the kidneys; they also involve the absence of those movements of the trunk whose pumping action affords a marked assistance to the flow of blood through the abdominal organs (p. 149). The congestion thus caused is not a good thing; it almost certainly renders the organs concerned more liable to inflammatory processes (see Chap. XXI), and if there has been established any tendency to catarrhal conditions (see p. 375), it aggravates that tendency. Popular experience has long associated a good color of the skin with health; and while it is not safe to make such an inference in all cases, pallor very frequently means internal congestion, unhealthy digestive functions, and greater liability to cold in the head or the chest.

5. *Muscular activity is the only thing which can be depended upon to increase the work of the heart.* While this fact makes caution and moderation necessary for persons having certain forms of heart disease, yet for the vast majority of people it is of the greatest hygienic importance to accustom the heart to reasonably hard work. Only in this way does it

receive the training necessary for its proper development and for the maintenance of its strength. Emergencies will arise when the heart is called upon for severe effort, brief or prolonged. The familiar example of the sudden "sprint" for a car is a case in point; and there are times, as in pneumonia, when the issue in sickness is largely determined by the endurance of the heart. In too many such cases, if the patient escapes the fatal issue, it is only with a heart permanently weakened.

It is important not only that the heart should be kept ready for emergencies but also that it be kept in condition for vigorous work as a regular duty of daily life. One of the worst of "vicious circles," as physicians call them, is the acquirement of a cardiac weakness by abstention from proper muscular exertion and, in consequence of this cardiac weakness, increasing disinclination to exertion of any kind whatever. The failure to take proper exercise leads to deterioration in strength and endurance on the part of the heart; and this cardiac deterioration, with the resulting discomfort of breathlessness, leads in turn to avoidance of muscular activity.

6. *Muscular activity is the one agent which increases the depth and frequency of the respiratory movements.* The hygienic importance of this does not lie in the better oxidation of wastes, since, so far as we have any accurate knowledge on the subject, it would seem that the processes of respiration during sedentary life more than supply the existing demands of the tissues for oxygen. The increased respiration is of importance rather because of the secondary effects of the respiratory movements in promoting the flow of blood and, especially, the flow of lymph (see p. 150).

It is probable that the "freshening effects" of muscular exercise are to a very large extent attributable to the improved lymph circulation in the tissues, and this effect, it will be remembered, is felt in the immediate environment of almost every cell in the body. The suction action of inspiration quickens the lymph flow from all organs outside the thorax (p. 151), and the increased pumping action of the respiratory movements themselves aids the lymph flow from the lungs and other organs within the thorax. Waste products are more completely removed from the lymph spaces surrounding all cells, and thus one of the most important of fatigue conditions is relieved (see p. 58). Where lymphatics are subject to the pumping action of contracting muscles and of the alternate flexion and extension of joints, the suction action of the respiratory movements is reënforced. This pumping action especially affects the lymphatics of the arms and legs and those of the abdominal cavity (through the action of the diaphragm and the trunk movements).

The increased respiratory movements also contribute to greater mobility of the ribs and to the better ventilation of the lungs. During vigorous exercise all lobes of the lungs are used, and the dangers attendant upon disuse of the apical lobes (p. 174) are largely obviated.

7. *Moderate activity exerts a favorable effect upon the digestive organs*, although the precise action involved is very complicated. Here also it improves the lymph flow, thus promoting absorption and producing better conditions in all digestive glands and in the muscular apparatus of the digestive tract; it prevents continued congestion and the unfavorable attendant conditions. It is probably also a direct stimulus to peristalsis, for unquestionably the exercises which involve movements of the trunk often prove a peculiarly efficient remedy for constipation.

The above summary is very far from a complete enumeration of the effects of muscular activity upon the organism, but it will suffice to show how essential an element such activity is in the life of the body. The training of the heat-regulating mechanism, the training of the heart, the improved lymphatic environment of every cell resulting from increased breathing movements and from the pumping action of mechanical motion, the relief of internal congestions and the favorable influence upon digestive functions, — all these things are fundamental to healthful cell life.

3. Muscular activity a necessity for all. We often hear of men and women who live to old age and do large amounts of mental work with seemingly little or no muscular activity, and it is sometimes suggested that the experience of these people proves that exercise is unnecessary. There are also on record a few cases of men who can drink large quantities of whisky without getting drunk, but it will not be contended that most men can do likewise. As to any line of right hygienic conduct there are some among the hundreds of millions inhabiting the earth who can do the reverse with impunity, but they are not to be taken as safe guides. The cases are very few indeed where abstinence from muscular activity persisted in as the rule of life is without disastrous results; the bad effects do not always come in a day or a week or a year, but sooner or later they almost invariably show themselves. We must never fail to distinguish carefully between the immediate and remote effects of any line of conduct; and nowhere is this caution more needed than in observing the effects of a sedentary life, the evil results of which, though sometimes long postponed, usually appear sooner or later.

Some muscular exercise is a hygienic necessity for every period of life; it belongs to no one age. Youth is the time when athletic sports, games, and all kinds of activity are most agreeable, most necessary, and most enthusiastically pursued. In old age the changes which take place in the arterial walls necessitate caution as to severe exertion. But these are only the extremes. Rarely indeed do we meet with people who would not be benefited by a walk of several miles a day, at a rate of three or four miles an hour; and it cannot be too strongly insisted that the inability to do this with enjoyment and profit is in almost every case because the *habit* of taking exercise is not kept up. The heart is not so strong as it once was; the connective-tissue elements of the muscles, the ligaments, etc. become sore upon taking exercise not because of any inevitable "old-age change" but because the ability to do the work easily has not been maintained by constant practice.

It would be amusing, if it were not sad, to see how the average adult American will try almost everything which holds out the slightest promise of maintaining some sort of health rather than take muscular exercise, — alcoholic drinks (to dilate cutaneous vessels), Turkish baths, massage, patent medicines, anything, rather than a horseback or bicycle ride, or a brisk walk, or some other simple and perfect remedy which stands within easy reach. It is not to be expected that when these exercises are first tried after years of sedentary life, they will be enjoyed; and too often the man or woman, instead of persisting patiently, draws the conclusion that the time for such things has gone and only resignation to old age is in order. When young men and women begin their work in life, it should be with a clear conception of the danger of falling into habits of muscular inactivity and with a conscious and strong determination to avoid this danger.

4. The conservation of the enjoyment of muscular activity. Muscular activity is so necessary for health, for the enjoyment of life, and for usefulness that the ability to take and enjoy it should be conserved at all costs. We should not only keep "in practice" by making it as much a daily habit as eating or sleeping but we should also avoid those unfavorable conditions which interfere with our enjoyment of it. Some will not walk a step more than necessary because, by the use of improper shoes, they have acquired deformed feet unable to support the weight of the body; sometimes a sunstroke, following incautious exposure to the hot sun, leaves the heat-regulating mechanism so injured that muscular exertion except in cool weather becomes unsafe or even dangerous; exposure to dampness often brings rheumatism — an almost insuperable barrier to pleasurable movement of any kind; some infectious diseases leave their trace in the form of an incurable organic weakness which makes muscular activity inadvisable. These things should, of course, be avoided for their own sake; they should be avoided also because of their serious indirect effects on health.

5. General character of the most useful exercises. To specify the exact forms or amounts of muscular exercise advisable would take us beyond the scope of the present work. Here, as elsewhere, the student must work out his own salvation. In the following sections we shall discuss, as far as possible, the characteristics of some special exercises; for the present a few general suggestions may prove useful. The muscular activity which formed part of the life of our ancestors may be described as generally moderate, though at times vigorous or hard; only exceptionally did it involve extreme endurance or great muscular strain. Our ancestors were not, as a rule, given to "tugs of war," or to putting up heavy dumbbells, or to making inordinately long runs, or to "giant swings" in the gymnasium; nothing like a hundred-yard dash or a four-mile boat race was a common occurrence among them. Where work of this kind had to be done it was left to those who, by reason of exceptional strength, were especially fitted for it; mankind as a whole did no such work, and it is not necessary (or even advisable) for most of us.

Nor can it be claimed that the cultivation of great muscular strength was a common practice. There was a much higher average of strength than among us, and we should probably be better off were our average higher than it is; but if we can judge at all from the history of mankind, such training as that required to break some college strength test is not demanded for hygienic purposes. Nor does our own experience tell a different story. Very strong men are no healthier nor longer-lived than those of only average strength, and, in general, *the athletic ideal is not the hygienic ideal.* It is not necessarily unhygienic, but it is not required for purposes of health.

It is not desirable that exercise taken for general hygienic purposes shall be unduly fatiguing. A moderate amount of fatigue is not unwholesome, since fatigue brings with it the desire for rest; nor is fatiguing exercise necessarily harmful. But exercise need not necessarily be of this character, and, in view of the other work of life, it is certainly better to avoid undue fatigue, especially when we cannot rest well afterwards. A walk of six or eight miles will do more good than one of forty or fifty.

6. Exercise for women. Muscular exercise is no less essential to the health of women than of men. Fortunately the day is past when false standards misinterpreted the truth that woman's most natural sphere in life is the home to mean that, tied down to the confining duties of household life, she should never know the joy of movement except in dancing (and sometimes not even in that), and then proceeded to make sure of the result by clothing her in narrow, pointed, high-heeled shoes, heavy skirts, and tight corsets. The reaction from this state of affairs, at times going to the opposite and undesirable extreme, has unhappily now and then produced in women exhibitions of mannishness which once led a lady to speak of "that terrible thing called muscular exercise." But disgust with these grotesque but avoidable consequences should not be allowed to blind us to the fact that a reasonable enjoyment of daily muscular activity is as much a necessity for women as for men.

B. General Muscular Exercise

The present section deals with the use of muscular activity for its hygienic effect upon the body as a whole; the next section deals with its employment for special purposes. Exercises undertaken for their general good effect are frequently spoken of as "hygienic"; the term is, however, objectionable, and we shall speak of them as *general muscular exercises.*

General muscular exercise is of hygienic value because it produces the physiological results which have been enumerated in the preceding section, — results which have been shown to constitute essential elements of the normal internal environment of the cells of the body. To review the separate offices of this ministry to the normal conditions of the body:

1. General exercises should produce to a considerable extent those physical and chemical changes which accompany muscular contraction, with the resulting effects upon the physiological condition of the muscle itself and upon the general internal environment, the blood and lymph.

2. They should exercise, and so train, the heat-regulating mechanism.

3. They should tend to relieve vascular congestion in internal organs, bringing the blood in larger quantities to the skin.

4. They should afford training to the heart.

5. They should increase the ventilation of the lungs.

6. They should increase the flow of lymph in the lymphatics and thereby improve the environmental conditions of all the cells in the body (see Chap. IV).

7. They should exert a favorable influence upon the digestive processes, promoting proper secretion and absorption and tending to prevent unhealthful conditions leading to constipation.

Such being the physiological ends sought for, we may conclude, as to the character of such exercises:

1. *They should consist of rhythmic rather than of sustained contractions.* These involve less fatigue, are more enjoyable, and especially facilitate the flow of blood and lymph.

2. *They should be vigorous,* somewhat prolonged, and should usually be continuous. A brisk walk or a run meets most demands; so do bicycling and many games. The strolls or saunters which are too frequently mistaken for exercise do not meet the reasonable hygienic demands of the body: they involve only an insignificant increase of chemical activity in the muscles, they hardly affect respiration, they do not train the heart, — in short, they do not produce adequate physiological effects to accomplish hygienic ends.

3. *They should involve considerable movement on the part of the trunk* as well as the limbs. Many excellent forms of exercise, such as bicycling, are somewhat deficient in this respect. It is not meant that sudden and violent trunk movements are called for, but that hygienic exercise should bring full change and relief from the constrained positions of the trunk imposed by the sedentary occupations of modern life. A vigorous walk, with its accompanying increase of breathing and trunk movements, fencing, and games which involve the throwing and catching of a ball, are especially good in this respect.

4. *They should be accompanied by full and free respiration.* The importance of this requirement needs no comment. Constricting clothing should not be allowed to interfere, and, as far as possible, the trunk should be held erect, the neck and shoulders back, so as to permit the freest movement of the upper ribs.

5. *It is advisable not to confine one's self wholly to one form of exercise.* Similar considerations to those which hold in the choice of food apply to some extent to exercise. At the

same time it must be admitted that perfect health can frequently be maintained to old age by using only one kind of general exercise, such, for example, as walking.

7. Considerations concerning fatigue. In the use of muscular exercise enough should be taken to secure the hygienic effects already described; but, on the other hand, the amount of work should not, as a rule, be so great as to produce marked fatigue. It is therefore desirable that we be able to measure with a fair degree of accuracy the amount and especially the intensity[1] of the work we are doing.

The most obvious and a most important sign of the intensity of muscular work is the feeling of fatigue thereby produced. But this is not the only sign, nor is it always a reliable sign. Intense work also deepens the breathing movements and may lead to breathlessness — often an indication of the overburdening of the heart. Such work also leads to greater blood flow through the skin and to increased secretion of perspiration. Consequently we may use breathlessness and profuse sweating (except in hot weather) as signs supplementing the evidence of fatigue, when we try to measure the intensity of the work we are doing.

With regard to the feeling of fatigue as a sign of the intensity of muscular effort two things should be remembered. In the first place, we may have decided feelings of fatigue when we are doing comparatively little muscular work; in the second place, the feeling of fatigue is often absent, even though the work may be very intense indeed. This fact has already been brought out in the chapter on fatigue.

8. Examples of marked feelings of fatigue with comparatively little work. We may be made very tired by unpleasant

[1] By *intensity* is meant the amount of work in a given time. We may take ten times as long to do the same amount of work at one time as at another; the total amount in the two cases would be the same, but the intensity of work (that is, the amount performed in one second or one minute) would be very different.

sensations from the joints and tendons or by walking in shoes which do not permit free play to the bones, ligaments, and tendons of the foot, and this when the amount of muscular exertion involved may have been very slight. It is well known that merely standing on the feet for a time will often cause more fatigue than a longer time spent in walking.

Again, some forms of exercise throw a relatively large share of the total work on some muscle or small group of muscles, while others distribute the total work more evenly over larger groups. Walking and running are very unlike in this respect; in the former the weight of the body must be lifted from the ground with each step — especially when we walk very erect — by the extensor muscles of the leg and chiefly by the extensors of the ankle joint; running, on the other hand, consists in a continual falling forward and the restoration of equilibrium by a more general action of the muscles of the body as a whole. A walk of four and a half miles an hour is much more fatiguing to a person in good training than a run of four and a half miles an hour, because in the former case a few muscles are thrown into very vigorous contraction and so give rise to severe local sensations of fatigue, sometimes accompanied by cramps in the muscles.

9. Examples of slight feelings of fatigue with comparatively large amounts of work; bicycling. Bicycle riding is remarkable for distributing the total work over large numbers of strong muscles, so that the amount done by each is relatively small; consequently, where there is but little hill climbing or no strong head winds, local fatigue is but slight, although the total work done by the body is considerable. Actual measurements of the carbon dioxide excreted have shown that this is much greater *per minute* in a ride of eight miles an hour on a smooth, level track than in walking three and a half miles an hour; in other words, the total work is greater. The well-known increase of perspiration brought about by such moderate riding points in the same direction:

the chemical changes in the body are greater and so is the associated heat production, and yet any cyclist knows that the conscious fatigue of the ride is as nothing compared with that of the walk. Moreover, in wheeling the weight of the body is not supported on the feet and we are thus to a large extent relieved from the unpleasant sensations produced by pressure and jar in the ankle and knee joints. It is a characteristic of moderate or even fairly vigorous bicycle riding that it produces a maximum of chemical change in the muscles with a minimum of fatigue. This is of great practical importance. The larger production of carbon dioxide involves deeper breathing and, as the student now well knows, increased work on the part of the heart.

Within proper limits this is, of course, good for the heart; there is some danger, however, that in the absence of conscious fatigue we may throw upon that organ more work than is good for it, and medical experience leaves no doubt that many cases of injury to the heart have resulted from injudicious cycling; that is to say, from "scorching" against strong head winds and in "showing grit" by refusing to get off and walk up very steep hills. There are occasions when it is not wise to be too ambitious and when "discretion is the better part of valor."

10. Games as examples of general exercises. Somewhat similar considerations apply to most of our more active games, such as basket ball, football, tether-ball, hockey, polo, etc. They are perfectly safe for healthy people when not played more vigorously than the training of the heart justifies; the fact that there is an element of danger in them is no reason why they should not be used, but it is a very good reason why they should not be worked to extremes, and especially why we should be sure, from competent medical advice, that there is in those who play them no organic trouble to begin with and that players are in good training when they play most intensely.

The choice of the kind of muscular work and exercise involves so many considerations other than those which are strictly physiological and hygienic that it is impossible to give in an elementary treatise like this any detailed discussion of the special merits and defects of each. We often have other aims in view besides the purely hygienic; thus the group games, such as football, baseball, basket ball, hockey, etc., train the spirit of coöperation and may be made useful means of moral training. In camping in the woods canoeing is not simply a means of exercise, but also a means of transportation, and under other conditions the same thing is true of horseback riding, rowing, etc. Wood-chopping, digging, porterage, and plowing are valuable means of livelihood. It is believed, however, that the principles here given will help the individual to form a correct judgment as to whether his work in life supplies him incidentally or inevitably with the needed general muscular activity for hygienic purposes and, if it does not, to plan to meet the want intelligently.

The combination of muscular exercise with some other pursuit is highly desirable, and when practicable often simplifies the hygienic conduct of life. But it is nothing short of a hygienic misfortune to lose *the youthful love of activity for its own sake.* It is well as we grow older to have golf, or a horse to be exercised (!), or a fishing preserve in the woods, to "take us out in the open air" and *make* us use our muscles; but a human being who is dependent upon something of this kind to drag him into activity cuts a sorry figure from a moral standpoint. Man's highest distinction is the fact that his actions may arise so largely from processes of psychic life within rather than from some immediate stimulus from without. The proper hygienic conduct of life involves moral fiber as well as physical fiber, and this is especially true of that absolutely essential part of hygienic conduct which depends upon the use of organs like the skeletal muscles, which are so largely subordinate to the commands of the will.

11. Importance of walking as a means of exercise. In their enthusiasm for athletic games and outdoor sports in youth and for other outdoor activities in middle life, the American people are always in danger of losing their love for the various forms of walking such as tramping and mountain climbing. Walking is the one form of general exercise for sound people which can always be had for the taking. For this reason, if for no other, it should ever be a part of all sound physical training to conserve the love of tramping and the ability to walk. Apart from the obvious fact that it is in this way that we can get closest to nature and the real beauty of the world in which we live, the possession of the love of the activity involved is one of the most precious possessions of our hygienic life. The man or woman who does not keep and improve this power by use must look forward to the same fate as the servant in the parable who hid his talent in a napkin, only to have it taken from him in the end.

12. Fresh air not a substitute for muscular activity. A word of warning is needed against the folly of supposing that fresh air is a substitute for muscular activity. Fresh air is one of our greatest hygienic blessings, and it is very desirable to live an outdoor life as far as possible. But too many think that lounging in the shade, or riding in the open air in an automobile, a carriage, or an electric car, does for them what muscular exercise alone can do. Especially as age creeps over us and the love of activity wanes from its disuse, more and more does the idea grow upon us that "fresh air" is everything. To some the possession of a comfortable carriage or a high-power motor car is a misfortune. At one of our most beautiful summer resorts someone said to a local physician, "Medical practice at such a place as this must be very unremunerative." "By no means," replied the man of experience; "people come here where they are tempted to overeat; in the place of exercise they lie back on the cushions of their carriages while they are driven about; their adipose tissue increases rapidly, and very soon it is true that to no class of people is the doctor so absolutely essential as to them." The student can easily make the application for himself. Indigestion, fatty degeneration, insomnia, loss of appetite, nervous prostration, and kindred ills rarely come to those who labor with their hands; and these ills can be largely prevented, even in those who must engage in sedentary occupations, by a wise and intelligent conduct of the physical life and, especially, by the daily reservation of an hour or so for vigorous general muscular activity properly correlated with the other work of life.

C. Muscular Exercises for Special Purposes. Corrective Work. The Gymnasium

The muscles may be used not only to produce those general influences which are necessary to the maintenance of health, but also to produce desirable special effects, among which the prevention and correction of faulty carriage and action are of great importance. In considering the use of muscular work for this purpose our subject naturally groups itself under two main divisions: first, faults of form or carriage of the body at rest — in other words, a bad figure; and second, faults of handling the body while it is in motion — in other words, awkwardness or clumsiness.

13. The shape or "figure" of the body. The human body may be chiseled in marble or molded in bronze, and the statue thus formed may recall to the mind the shape or figure of the person it represents. But the shape of the living body is not rigidly fixed, as is that of the statue. The bony skeleton is sometimes called a framework, which supports the muscles, viscera, skin, etc. While this is to some extent true, the organs are not rigidly supported by the skeleton, as the canvas is supported by the poles and ropes which constitute the framework of a tent. In other words, the bones of the skeleton are not rigidly joined together; they do not of themselves make a self-supporting framework; the strong ligaments which pass from one bone to another simply limit or guide the movement of the bones (p. 16); they do not, strictly speaking, bind them together. If all organs save the bones and ligaments were removed, the skeleton would collapse. It is itself held upright by the muscles, which determine what position the bones shall have with regard to one another; and it is more correct to say that the muscles support the skeleton than that the skeleton supports the muscles.

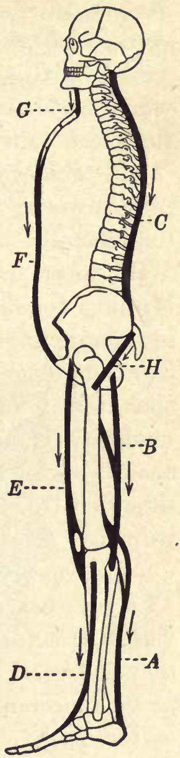


FIG. 112. Diagram showing the action of antagonistic muscles which keep the body erect. After Huxley

Arrows indicate the direction of the pull, the feet serving as a fixed basis of support. The muscles *A*, *B*, *H*, and *C* keep the body from falling forward; *D*, *E*, *F*, and *G* keep it from falling backward

14. Round shoulders as a type of faulty carriage; their cause. The carriage of the shoulders well illustrates the closing statement of the last paragraph. Some people have square, while others have sloping, shoulders; in some the shoulders are held back so that the upper portion of the back is approximately flat, while in others they droop forward, thus causing the upper chest to be more or less contracted and the back "round." To some extent these differences may be due to hereditary structure, but they result, for the most part, from causes which are largely, if not entirely, under individual control. There is little or no excuse for round shoulders in healthy people, and the marked effect of training is evident in the fine bearing of well-trained soldiers. The truth of this statement is seen when we consider how the deformity is usually acquired, the chief causes being the following:

(1) *Faulty posture.* Round shoulders are uncommon among people whose work requires an erect carriage of the body; for example, among those who carry things upon the head. With most, however, the occupations of daily life lead to bending forward over work; writing, drawing, sewing, lifting, gardening, paving, machine and tool work at once occur as examples. The trunk is held in such a position that the shoulders tend to fall forward of their own weight. This tendency is aided by the wrongly curved backs of most chairs — which seem as if planned especially to force the shoulders forward — and in boys by the use of suspenders worn too short or too tight.

(2) *Improper balance in the play of antagonistic muscles.* The position of the shoulders with reference to the ribs, vertebral column, and breastbone is largely dependent upon the action of several groups of antagonistic muscles, the most important of which are those of the breast and those of the back. Figs. 113 and 114 show the general antagonistic action of these muscles. The contraction of the great breast (or *pectoral*) muscles pulls the shoulders forward and nearer the breastbone; the contraction of the back muscles (*rhomboideus*, *trapezius*, and others) pulls them backwards and nearer the backbone. Both groups of muscles are kept in a state of sustained moderate contraction (or tone) by the nervous system; but if the back muscles relax, while those of the pectoral group remain in tonic contraction, the shoulder will be pulled forward and the back will be round. Obviously the maintenance by the nervous system of the proper balance in the action of these and other antagonistic groups of muscles is essential to correct carriage of the shoulders.

(3) *Deficient use of the back muscles, with or without the excessive use of the breast muscles.* Most occupations and activities involve greater use of the breast muscles than of

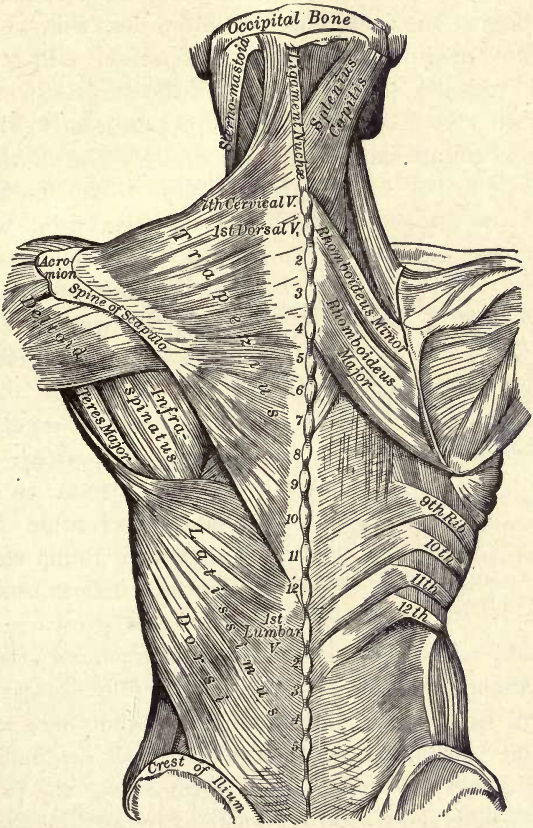


FIG. 113. Some of the muscles of the back

On the left side are shown the muscles immediately under the skin; by dissecting away this first layer, there are exposed the muscles shown on the right side

the back muscles. Striking a blow with a bat or an ax, throwing a ball, and similar actions are more usual than acts (like pulling taffy) which extend the arms and draw the shoulder blades closer together. Movements of the first kind obviously strengthen the breast and stretch the back muscles; those of the second kind have the opposite effect. Consequently any marked preponderance of pectoral action tends to elongate the back muscles; and unless this is counteracted by movements of the opposite character, which stretch the breast muscle, the pectoral and back groups become "set," as we may express it, in improper relative lengths. The result is round shoulders. Accordingly one of the most important things to have in view in gymnastic work is the use of movements which train the back muscles and stretch the pectorals, thus counteracting the effect of the one-sided use of these two groups of muscles in ordinary occupations.

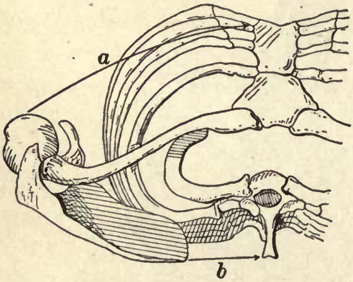


FIG. 114. The skeleton of the trunk seen from above. After Demeny

Showing the antagonistic play upon the shoulder of the muscles of the breast (a) and back (b)

15. The period of growth especially favorable for the acquisition of round shoulders and other deformities. The length of a growing muscle is determined largely by the distance between its origin and insertion[1] during the period of growth. The breast muscle will grow to be a longer muscle when the shoulders are held back by the back muscles than when they are habitually allowed to droop forward. In the former case the pectorals grow to sufficient length and do not tend to pull the shoulders forward and downward, and we avoid the excessive length

[1] Where a muscle is attached by its two tendons, the point of attachment against which it usually pulls or is fixed is known as its *origin*, while the one it usually moves is known as its *insertion*. Thus the origin of the pectoral muscle is the breastbone and ribs, its insertion the shoulder and the upper arm.

of the back muscles, which makes it necessary for them to take up their own slack before they can keep the shoulders in position.

The student can now appreciate the fact that it is in youth, during the period of growth, that deformities are most readily acquired and most easily corrected, for the muscles, the ligaments, the bones, are then in their formative stage. In the case in point, if the boy or girl holds the shoulders properly, the pectoral and back muscles of each side adjust themselves to their proper length, and the shoulders grow into the correct form, just as the sapling

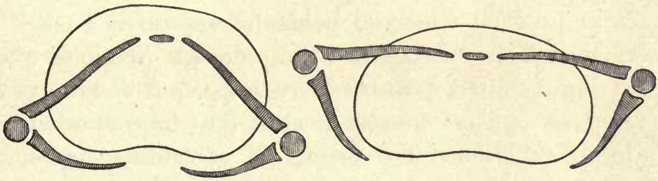


Fig. 115. Correct and incorrect positions of the shoulder girdle. After Demeny

which is not bent nor deprived of proper sunlight grows into the symmetrical, beautiful tree. During the period of growth, then — say up to at least the twentieth year — we can hope to accomplish most in correcting *and, especially, in preventing* deformities. The correction and prevention of round shoulders evidently depend upon the proper training and use of the muscles which play upon the shoulder; it is therefore a legitimate part of gymnastic training, for gymnastic training is largely the art of learning to use the muscles properly.

Where there is a special defect to remedy or prevent, special exercises are required. These are of the general character of the "setting-up" drill of the soldier; in the case in point we accomplish our purpose by using movements which, in the first place, stretch the pectorals and even overextend them; in the second place, give to the back muscles the exercise which they fail to get in our ordinary occupations and so bring up their strength, their ability to withstand fatigue and to maintain the tonic contraction demanded of them; and, in the third place, give us the knowledge of the correct position of the shoulders.

16. Education of the consciousness of correct posture. In explanation of the last point we may say that when one habitually carries the shoulders properly he feels that he is taking an awkward position when he allows the shoulders to droop; on the other hand, the man who habitually allows his shoulders to droop forward feels that he is in an unnatural position when he holds his shoulders back. The sensations which come from the muscles, tendons, joints, etc. during habitual posture have impressed themselves on the mind as signs of normal posture; to take another position is to experience the feeling of something unusual or abnormal. To correct faulty posture it is first necessary to know the muscular feeling of correct posture, something which can be learned only by taking the correct position and taking it frequently. The man who has never done this knows no more of correct posture than one who is blind from his birth knows of the color of a landscape, and under these conditions there is no impulse to correct faulty posture. On the other hand, the more frequently the man actually experiences the muscular sensations which come from correct carriage the better does he become acquainted with them and the more surely will this knowledge inform him whether he is carrying himself properly or not.

17. The more important faults of form and carriage. We may now pass to the consideration of the more important deformities, which it is the aim of special muscular exercises to prevent or correct.

(1) *The failure to hold the neck erect* (allowing it to bend forward). This results naturally from the fact that the

weight of the head bends the neck, provided the tendency is not corrected by the proper training of the muscles of the back of the neck and trunk. The position of the head usually taken in reading, sewing, etc. is another cause of this bad habit.

(2) *Round or stoop shoulders.* These defects have already been sufficiently dwelt upon (II, 315).

(3) *Too great backward (dorsal) convexity of the spine in the thoracic region and too great forward (ventral) convexity of the spine in the abdominal region.* A certain amount of such curvature is normal in these regions (see Chap. II), but there is usually a tendency to excessive curvature because of the weight of the parts of the body which the spine must support. Everyone knows that it is an effort to sit erect; and this feeling of effort comes from the fact that the spine is straightened, or, rather, its curvature kept normal, by the action of a somewhat complex group of muscles — the erectors of the spine. To sit or stand or walk erect involves the activity of these muscles; when they cease to act, the faulty curvature becomes more pronounced. Hence the value of all exercises which tend to straighten the spine — exercises, for example, in which, while standing on the feet, we try by our own muscular effort to make ourselves as tall as possible. They train and strengthen the muscles in question; they stretch their antagonists, just as throwing the shoulders back stretches the pectorals; and they impart to us by actual experience the sensation of being erect.

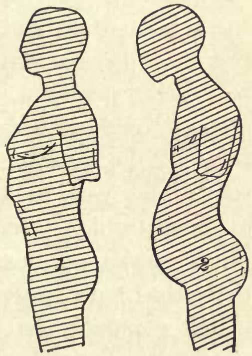


Fig. 116. The results of proper (1) and improper (2) carriage of the vertebral column. After Demeny

(4) *Lateral curvature of the spine.* When the spinal column and its attached ligaments and muscles are properly developed,

there is little or no lateral curvature of the spine; the two halves of the body are symmetrical with regard to the median plane of the body, although a considerable amount of bending of the spine as a whole to one side or the other is possible. It is, however, quite possible, by maintaining incorrect positions, to acquire a more or less pronounced lateral curvature in which the muscles and ligaments of the concave side become shortened and those of the convex side lengthened. Perhaps nothing is so responsible for all these faults of curvature of the spinal column as improper positions at the school desk, and much can be done to prevent them by properly constructed school furniture and careful attention to correct position. But it is not wise to depend on these alone. No desk has been constructed in which correct posture can be indefinitely maintained with ease, and we have still in any case to contend with the force of gravity. Active exercises which straighten the spine should supplement the other measures. Experience has well established the fact that the true preventive or remedy lies in movements which elongate the spine.

(5) We have elsewhere (p. 174) pointed out the important action of the muscles of the abdominal wall in supporting the abdominal viscera, especially those, like the stomach, the spleen, and the intestine, which are suspended from the dorsal wall of the abdominal cavity. Fig. 157 will at once make clear how the relaxation or elongation of the abdominal muscles, by removing support from these viscera, permits their weight to pull unduly upon the mesentery and so to stretch this support. It is also not improbable that the tense mesentery at times, by pressing upon thin-walled veins and lymphatics, interferes with the circulation of blood and the flow of lymph in some organs, and so leads to trouble. A pot-belly is not a thing of beauty, and there is every reason for thinking it to be undesirable from the hygienic point of view. It is prevented, in the first place, by every

movement which prevents undue lumbar curvature of the spine and, in the second place, by exercises of the abdominal muscles, which result in their improved tone. These, however, *like all corrective exercises*, must be followed up by maintenance of the correct position of the trunk.

18. Special exercise for the training of nervous coördination. A man or woman may possess none of the deformities noticed above — the anatomical form of the body may conform to the best ideals — and yet the movements of the body may be awkward, inexpert, ungraceful. In other words, the muscles may be well developed, but the nervous system may be deficient in the power of easily coördinating their action in the accomplishment of desired ends.

This defect in the nervous system is sometimes due to inherited or other structural imperfections in the mechanism, but it is far more frequently the result of lack of proper training by use. It is an old saying that skill to do comes by doing, and we see this illustrated every day in countless ways. The man who writes little writes with difficulty not because he lacks the neurones necessary to coördinate the action of the muscles of the hand but because these neurones have not been drilled by practice. The student will recall the comparison made on page 88 between the training of the neurones and the drilling of an army, and he may now make the application to the case in point; for just as we learn to walk by trying to walk and keeping at it until every muscle works at its proper time and in its proper way, so, in general, the maintenance of the balance when the body is at rest and when it is in motion, no matter what we are doing, is the result of doing correctly the action we are trying to learn. The range of activities for which we can train is very extensive; playing upon musical instruments, the execution of gymnastic feats on the parallel and horizontal bars, the traveling rings, or the trapeze are only a few examples of the training of the nervous system by practice.

A large part of gymnasium work consists in this sort of training, and there is almost no limit to the forms of exercise to which we may train — vaulting, jumping, balancing the body on one foot while various movements are made, the tricks of the parallel and horizontal bars, trapeze, etc. Is there any principle to guide us in the choice of what we shall do? In reply to this question we may say that the leading principle should undoubtedly be that of training for what will be useful, and while we need not discard all training which cannot be justified on this ground, that which is useful should not be sacrificed to that which is not useful. A large amount of skill is required to walk upon the hands with the feet in the air, and the thing can be done very gracefully by training; but it is certainly better to cultivate the habit of walking gracefully upon the feet. And yet one may see professional gymnasts who are extremely graceful while performing their tricks, but whose gait is clumsy and awkward.

19. Balance exercises. It is evident that by far the greater number of our customary coördinated movements are made on the feet. Hence the value of so-called *balance* exercises in the widest sense, whether they consist in the execution of difficult movements while standing on one foot or on the "walking beam" or in making a proper landing from a jump or a vault; all of them afford training of those reflexes by which we retain control of the body in motion, thus securing grace of posture and carriage.

The general purpose of training these reflexes is the same as the purpose of those exercises which correct deformities; they do for the nervous mechanism of the movement what the others do for the skeletal parts and the muscles which play upon them; they give the training of use and prevent atrophy from disuse.

Both these ends, the corrective and the so-called coördinative, are best secured by the use of gymnastic movements;

and the increasingly sedentary character of much of our modern life correspondingly increases the value of gymnastic work, especially in the period of youth. It is well to learn and understand the most useful exercises and, even in adult life, to have resort to them as often as may be necessary in order to hold fast what has been gained.

20. The gymnasium as a means of general muscular exercise. Under the conditions of city life, especially in winter time, the gymnasium is also useful in supplying general exercise in the form of running, gymnastic games, etc. It is better to seek outdoor work as far as possible for this exercise, but there are times when those living in the heart of crowded cities cannot get to the country, and outdoor exercise in town is not all that is to be desired. While there is sometimes a tendency to extol unduly the value of gymnastic work, there is equally marked ignorance in other quarters as to what the gymnasium may accomplish. Our cities are vastly better off for their Y. M. C. A. and other gymnasia, and we cannot afford to discourage any means of properly directed physical training.

21. Hygienic value of corrective work. Before leaving the subject of corrective and coördinative work we may answer a question which is frequently asked: Has it, after all, any hygienic value? All will readily grant that this part of physical training has an æsthetic value and that the cultivation of the taste for correct form and carriage in one's own person is to be commended. But is a man less healthy for being round-shouldered? The answer is that he may or may not be less healthy. The deformity of round shoulders carries with it the lessened use of the upper ribs in breathing; and while one man or woman may escape dangerous consequences, another may not, — indeed, we know does not, — and it is the part of wisdom to avoid the danger as far as possible. In one a pot-belly may be consistent with perfect health, while in others it is not. One may go through life with some faulty curvature of the spine and not suffer from it, but thousands of persons have to consult physicians every year because of such faults. Many a man wears improper shoes without bad results; hundreds pay for them by flat foot and suffering which at times amounts to torture. There is not a single deformity enumerated above which may not prove a serious matter; and when it is so easy to avoid most of them, it would seem from a hygienic point of view well worth while to do so.

The hygienic value of corrective and coördinative work is justified, however, still more effectively on another ground. The tendency to take general exercise is directly proportional to the excellence of the neuromuscular mechanism of the body. The man who is awkward and clumsy, who can make but few movements, does not enjoy general exercise as does the man who has good control of his muscles and can make many movements. It is probably not too much to say that a very large proportion of the people who settle down to a sedentary life with the coming of their thirty-fifth or fortieth year do this because they can do so little with the body and because exercise is consequently monotonous and distasteful. We can undoubtedly preserve more readily the love of movement for its own sake when we have a body which can move freely and easily, skillfully and joyously, than when we have one which is never so much at home as in an easy-chair or upon a soft bed, and we have shown above (II, 304) how valuable is this joy of movement to the body as a whole.

CHAPTER XVIII

THE HYGIENE OF THE NERVOUS SYSTEM. REST AND SLEEP

In no respect do the conditions of modern life stand in more striking contrast to those of former times than in the increasing importance of mental work in contrast with muscular work as a means of livelihood. Not only are there more professional men — such as lawyers, editors, physicians, teachers, and the like — but the character of modern business life involves the ceaseless use of the nervous system both on the part of those who direct large enterprises and of those who occupy subordinate positions. The clerk in a bank, as well as the president or cashier, is "living by his wits" and is using his brain to an extent almost unknown until within the last century. Never was competition so keen; never has it been so necessary to inform one's self minutely as to market conditions of demand and supply; never before has the margin of profits been so small; never before has it been so necessary to avoid waste; and never before has it been so difficult to protect one's self against novel and unforeseen conditions. Truly the modern business man must be ever awake, ever alert.

Nor is this all. With the introduction of the telegraph and telephone, communication between man and man is facilitated; the widespread employment of stenographers results in an increase of letters received and sent; and in other ways the number of matters demanding attention is multiplied manyfold. Moreover, the increase of wealth has enlarged the possibilities of life; concerts, art exhibitions, books, crowd upon us; social engagements are multiplied; so that as a result we are kept ever on the alert, and the man or woman who does not firmly decline invitations, engagements, and efforts which would overcrowd life to no good purpose experiences elements of distraction or fatigue or worry which tell upon health and too often lead to what we call nervous prostration.

For no student of the practical problems of hygiene can shut his eyes to the marked prevalence of nervous prostration and even insanity, or fail to recognize the evident connection between these things and the intensity, the hurry, the unrestful character of the lives we lead. Probably there is no more pressing problem of practical hygiene than that which is thus presented, for here, if anywhere, "an ounce of prevention is worth a pound of cure."

Even where there is no question of nervous prostration or insanity, a large number of people suffer from nervous troubles of one kind or another which interfere seriously with their work and with the legitimate enjoyment of life. We have seen how close is the connection between all parts of the nervous system and also how conditions of the nervous system may and must influence nutritive and other functions of the body. The two are most intimately bound together; and many a man or woman fails to secure the blessing of good health because intense, unremitting work is demanded of the nervous system such as would never be imposed on the muscles or the stomach or the skin. Consequently the avoidance of actual nervous prostration is but a small part of what must be accomplished by the hygienic conduct of life; a far more pressing practical problem is the lessening of daily strain, worry, and fatigue, which are the precursors of the more serious troubles and the avoidance of which affords the only sure means of defense against the all too common and distressing breakdowns of useful lives.

1. Nature of the impairment of nervous efficiency. The work of the central nervous system, unlike that of a muscle, does not require the expenditure of large amounts of power, nor does it, like that of a gland, involve considerable chemical change. The brain and cord consist of innumerable units — the neurones — with very delicate and intricate connections between them. Just as we compare the muscle to an engine, and the gland to a chemical factory, so we find a similar comparison for the nervous system in a piece of delicate and intricate mechanism such as a fine watch. The danger is not so much that it will be strained by heavy work nor even that it will be unduly fatigued by the accumulation of the waste products of its own activity, but rather that its delicate connections will be injured, as a watch may fail to keep time when its bearings are not properly oiled or when particles of dust make their way into them. In the work of a muscle it is not so important if some of the fibers fail to do their work, since each fiber has only the function of exerting its own pull on the tendon, and if one fails it is only necessary for the others to pull harder; and somewhat similar considerations hold with regard to the gland. The living units of which these organs are composed work more or less independently of each other, and the work of one cell does not directly affect the work of another. The neurones, on the other hand, are *interdependent units*, and the failure of one synapse to convey the stimulus from one neurone to another may mean inefficient work on the part of the whole mechanism or even the failure of the mechanism to work at all.

2. Means of repair in the nervous system. In a watch every precaution is taken to prevent such interference with the working of the mechanism. The axles of its wheels are made of the hardest steel, as also are most of its cogwheels and pinions; jewels are also used in the bearings so as to reduce wear upon the parts to a minimum. Above all, the mechanism is encased to prevent access of dust and moisture from without. Such is not the case with the nervous system. Its parts consist of living, irritable, unstable protoplasm liable to undergo change with changes in its surroundings. So far from being protected from the access of foreign matter, its cells are bathed by the blood common to all organs and are exposed to whatever unfavorable condition may obtain therein.

But nerve cells have in common with all other living cells an advantage possessed by no lifeless mechanism, namely, the power of *self-repair.* A watchmaker must clean and put a watch in order. The nervous system repairs itself if given a chance to do so, and for this purpose requires only that the intensity of its work be lessened by rest and sleep. Recurring to our figure of the signal tower in the yard of a large railway station, the activity or "strain" of the nervous system during our waking hours may be compared to the work in the signal tower during the rush hours of the day, while our sleeping hours would correspond to that of the signal tower during the small hours of the morning, when trains are no longer entering and leaving every minute; and just as it is then that tracks and switches may be most thoroughly inspected and repaired, so it is during sleep that the nerve cells can best attend to their injuries and restore the whole system to its highest degree of efficiency.

It is, perhaps, the chief function of sleep to insure to the delicate and complicated mechanism of the nervous system this chance for repair. Indeed, sleep is the only means which insures to *every neurone* due rest from activity. With the changing demands of active life, first one and then another combination of neurones is called on for activity; but it not infrequently happens that some neurones of the second combination belonged also to the first, and there are many which are constantly in action, such, for example, as those of the vasomotor system, which regulate the supply of blood to the organs. For this reason mere change of occupation, though affording partial relief, cannot insure perfect repair. Those who would define rest as "selected excitement" should bear this fact carefully in mind.

3. The care of the nervous machinery; rest and sleep. If a locomotive is to be kept in the state of high efficiency, it must not be worked without ceasing until something goes wrong. When a train is to be pulled five hundred miles it is customary to change engines two or three times on the run; and these changes are made not because the first engine cannot pull the train to its destination on schedule time but because heating occurs, or dust finds its way into the bearings, or the strains and jars impair adjustment; and it prolongs the life of the machine and its good working to remove the dust, cool the parts, and otherwise frequently put the engine in perfect order. When an engine breaks down, it is usually because some one part has given way. With proper care a good machine should wear out but not break down.

The central nervous system, although infinitely more complicated than a locomotive, is far less durable as a mechanism. Its bearings are not made of hard steel, but of living, irritable protoplasm keenly susceptible to injury. In the numerous connections between neurone and neurone there is far more chance than in the steam engine that some one part will fail to do its work; *and the main principle of its hygienic care is to oil the bearings and clean and repair the machinery, by repose and sleep, before the danger of a breakdown is imminent.* Rest, and especially the rest of sleep, is the one preventive, the one sure cure, for these unfavorable conditions; only in this way is the fatigued neurone withdrawn from work and given the chance to repair itself and to return to its normal condition.

The cardinal principle in the care of the nervous system is thus the same as that in the care of the steam engine.

Do not often call upon it for activity of any kind when conditions of undue fatigue are likely to be present. Go to the performance of every physiological activity, to digestion, to study, to muscular work, to social life—*for all these mean nervous activity*—as far as may be with a rested nervous system. Of course to do this is not always possible; there are times when we must drive the body, despite the fact that it is physically tired; but this ought to be the exception, never the regular order of life.

4. Examples. Let us suppose that someone, man or woman, after application at sedentary work for six or more hours, has some time free before the evening meal and that, tired and perhaps nervous, relaxation is sought in a brisk walk, which is almost immediately followed by dinner. The effort which the digestion of this, perhaps the heaviest meal of the day, costs the nervous system shows itself in the stupid, almost somnolent condition which often follows. The body is trying to do hard work with a tired nervous system some of whose bearings need oiling; its owner is making the mistake of continued activity without opportunity for the rest and repair which a nap of fifteen or twenty minutes, or even absolute idleness and complete muscular relaxation without sleep, for half an hour or so before the meal, might have given him.

Again, there are times in everyone's life when some unusual strain must be borne; when, for example, after the day's work watch must be kept at a sick bed during the greater part of the night. Too often people will undertake this strain, expecting to "make up" the loss of rest when it is over, even when it is possible to prepare for it by an hour or so of sleep beforehand. We seldom work steam engines in this way. Should we treat the nervous system less carefully than a steam engine?

These examples must suffice. The application must be made by each individual according to his work in life. If work is undertaken which requires constant activity from early morn until late at night, the case is hopeless and the only remedy is a change of occupation. Only gross ignorance of the plainest facts of human experience, as well as of physiological science, can excuse such conduct.

5. How much sleep is advisable? Different people undoubtedly require different amounts of sleep, but it seems safe to say that the majority of adults require from seven to eight hours a day; children and young people require more. It is, however, an interesting question whether all of this should be taken at one time or not. Since the nervous life of to-day is more intense than was that of our ancestors, it is all the more needful that we keep the nervous system in a continuous state of high efficiency. To go about the duties and pleasures of life from early morning until late at night without a moment's rest is a great mistake; we are then doing what the engineer would do who should run his engine all day, feeding it with coal but without giving it a drop of oil, without tightening a nut, without cleaning a bearing. As the play of nervous activity goes on, calling now upon one combination of nerve cells, now upon another combination, those nerve cells which belong to more than one mechanism are called on for more than their share of work, and every mechanism to which they belong may be to that extent impaired. The stimulus of the will must be more vigorously applied, and as this becomes ineffective, the individual is tempted to use stimulants, as the whip is applied to tired and straining horses or as blows were showered upon galley slaves in time of battle.

Contrast with this the benefit of brief sleep during the day in facilitating night work. Some persons, it is true, do not seem to be thus benefited, but the vast majority are. And the benefit is out of all proportion to the time spent asleep. We are tired, and work is difficult not so much because the whole nervous system is exhausted but because unfavorable conditions of fatigue, etc. have come in at important points; during even a short nap, with its marked muscular and nervous relaxation, normal conditions are restored and the whole mechanism then works on with less effort, less general fatigue, less local injury.

6. Nervous rest in change of work. Sleep is the very best means of insuring nervous repair, because it is the only condition which involves complete relaxation. There is, however, some rest, or at least some refreshment, in mere change of employment; as when, for instance, we pass from mental work to physical exercise. Calling into play a new group of nerve cells gives a chance for rest to many cells which have previously been active. And at times we feel tired after mental work because we need muscular activity rather than sleep. The tired feeling may come not from tired nerve cells but from the want of what the muscles might furnish (see Chap. XVII). At such times muscular exercise to some extent, perhaps to a great extent, refreshes us; and in general we maintain a higher degree of working power by judicious variety of activity. But it must be remembered that in the long run neither muscular exercise nor any other change of occupation can take the place of the complete relaxation and refreshment found in sleep. It is, indeed, doubtful whether there is any change of employment which brings with it an entire change of nervous activity. A certain number of the same cells, already weary, are still kept at work, as has already been explained above; and it is *by sleep alone* that *every* cell has its natural opportunity for repair.

7. Conditions favorable to sleep. (1) *Moderate bodily fatigue.* The beneficial influence of a moderate degree of bodily fatigue in bringing on sleep has been commented upon (p. 63), and this is an important office in the ministry of muscular activity to the body as a whole. On the other hand, when fatigue is very marked, and especially when decided soreness is present, it often happens that we cannot go to sleep because the afferent painful impulses which are then streaming into the central nervous system stimulate us and so keep us awake. Hence moderate fatigue favors slumber; over-fatigue and especially muscular soreness or lameness often render it more difficult. Many people suffer from insomnia because of lack of muscular activity; others because of injudicious muscular activity.

(2) *Dilation of the arterioles of the skin.* A second condition favorable to normal slumber is dilation of the blood vessels of the skin (p. 155). We know that it is difficult to go to sleep when the skin is cold, or, indeed, when only the feet are cold, and of this physiology gives the ready explanation. When the skin is cold its blood vessels constrict and we cannot secure the needed dilation in that organ. Sometimes for no apparent reason one is unable to go to sleep, and this sleeplessness may last for several hours until the addition of a light blanket to the bed covering brings on sleep within a few minutes. The individual was unconscious of any distinct feeling of cold, yet the temperature of the skin was sufficiently below the normal to maintain the tonic constriction of its arteries. The use of warm drinks or a tepid bath before retiring also finds its explanation in the cutaneous dilation thereby induced. Very hot baths, on the other hand, by overheating the skin and stimulating the afferent nerves of warmth (p. 258) often delay the onset of slumber. Too much bed covering often has the same effect.

(3) *Exclusion of afferent impulses.* To secure rest to the efferent neurones and, indeed, to the central nervous system in general, they must be protected from afferent stimulation. Not only should the room be darkened and sound excluded as far as possible but the sense organs of the other senses as well should be protected from stimulation. We have just pointed out the necessity of avoiding stimulation by cold and heat and also by pain arising from excessive muscular

fatigue. Similarly, those sensations arising from any form of bodily discomfort (for example, those arising from constricting clothing) should be relieved. This would seem almost self-obvious did not many people assert their inability to secure short naps in the daytime, when they have only tried to do so by throwing themselves in their street dress on a lounge in a bright room in which conversation is going on. Finally, one group of afferent impulses must not be forgotten, namely, those from the muscular sense (p. 259). From every contracting muscle sensory impulses stream into the nervous system; and although these do not strongly affect our consciousness, nevertheless they stimulate the lower nerve centers and prevent their complete inactivity. Hence the importance of muscular relaxation preliminary to slumber.

8. Muscular relaxation in sleep. All have noticed, when falling off to sleep, the feeling of relief from strain; the framework of the skeleton seems to be held together less rigidly, and finally, as we lose consciousness, relaxation seems complete. At other times when sleep will not come many have felt the inability to relax; when, as it has been well expressed, we seem to be afraid that the bed will slip away from under us and we must hold on to it. We have seen that during waking life the nervous system is continually sending out impulses which keep the muscles in a state of moderate contraction and thus among other things liberate heat for the maintenance of the body temperature. Usually this tonic activity of the motor neurones must be more or less relaxed before sleep will come, and the inability to release it is one of the danger signals of the nervous system. There can be no doubt that when nervous work is pushed too hard against unfavorable conditions, the nerve cells develop a condition of excessive irritability, so that they are discharged by afferent impulses or other stimuli which would ordinarily not affect them, and they maintain this irritable condition even in the presence of general bodily fatigue. Normal rest is, of course, extremely difficult or quite impossible under these conditions, which for this reason alone should be attended to at once. The trouble may be in some general or special unhygienic condition of life — impaired digestion, insufficient muscular activity, the presence of undue anxiety, etc.; these should be inquired into and remedied if present, but the trouble is usually the result of pushing activity of different kinds for too long periods without cessation. In other words, we have lost the ability to relax because we have not *practiced relaxation.*

9. Conservation of the ability to relax. The ability to relax is something which, like all phenomena of nervous life, depends on practice. Indeed, it is not improbable that it is something more than a mere process of desisting from activity and that direct active processes of inhibition (see Chap. XV) are concerned in it. All have known people who can go to sleep the instant they lie down, and they can do this — it would almost seem by an act of the will — because they have often done it. It is a power which can indeed be cultivated too well; by too frequent repetition of the process of taking a nap and by sleeping too long at night, there may be acquired a diminished irritability of the nerve cells, which makes attention to work a very difficult matter and long-sustained attention almost impossible. Those in this condition may escape the danger of nervous prostration, but they impair their usefulness in life.

The true path, as in other matters of personal hygiene, is that between these extremes. When one rises at seven or eight in the morning a short period of rest in the afternoon is sufficient; the persistent practice of the act of relaxation every hour or less is apt to lead to loss of muscular tone and of nervous efficiency in general. At the same time the habit of *momentary* relaxation in the midst of the day's work is a valuable aid, partly in bettering conditions at the time, but chiefly in retaining the power to relax when it is wanted for longer periods of rest.

10. Drugs are delusive and dangerous. The physiologist cannot condemn too strongly the substitution of stimulants for the proper regulation of work and rest. The reader will see at once what this course of action may be expected to accomplish; the stimulant is an antagonist of relaxation; the nerve cell becomes more and more irritable as it is pushed harder and harder; finally, it reaches either the condition of excessive irritability or else that of being unable to work without the stimulant. It has adapted itself to the presence of the stimulant in its environment; it is trained to work under drugged conditions, and it cannot work without them. It may be safely asserted that, in general, the time above all others when stimulants should *not* be used is when we are tired out; to use stimulants regularly, day after day, in place of rest is shown by experience to be one of the most fatal of errors.

Nor, on the other hand, can we condemn too strongly the use of narcotics to produce sleep. Probably none of these drugs is capable of producing normal sleep; and while in times of emergency the physician must have recourse to them, they should never be relied upon in place of the hygienic conduct of the whole life. Many of them, and some of those in common use, are very dangerous, and none of them is known to be above reproach.

11. Mental work and overwork. Much nonsense is said and written about "working the brain too hard." If by this is meant working it too long at a time without rest or without stopping for muscular exercise; if it means the attempt to do more sums in arithmetic, to read more Latin or German, to write a longer composition, or to master more science than the hours of study justify and so prolong these hours of study to the neglect of other hygienic demands, no objection can be made to the phrase; but if it refers to the hard mental work and close application required for a reasonable time by a sum in mathematics or a passage in Latin, we may well hesitate to regard such work as in any degree dangerous. The world is overflowing with people who have never acquired habits of mental concentration and hard thinking, and yet their general health is no better than that of persons who have acquired such habits, while their mental powers often suffer severely by comparison.

It is very important to understand clearly that it is *misdirected* nervous activity and not hard mental work in itself or the concentration of attention which mental work requires that leads to bad results. It is a part of our normal life to do mental work and to cultivate the power of close application to that work; it is a part of education to develop the power of concentration and attention against resistance and inclination, and experience shows that this may be entirely consistent with the maintenance of health. But when a student "crams" for an examination for two or three days, with the minimum of sleep during the period, and breaks down after it is over, it is not merely mental work which should be blamed for the result, for he would probably have broken down if he had attempted to work a typewriter during the same time, with no more relaxation or rest. The real cause of the trouble is the *too long-continued* use of the nervous system.

12. The influence of mental and moral states. Finally, it must also be remembered that psychical processes exert a profound influence upon the well-being of the brain and spinal cord. It is a matter of common experience that emotions, feelings, moods, worry, etc. profoundly influence human conduct and so indirectly affect health, especially the health of the nervous system. It is also certain that they exert a more direct physiological influence on the bodily functions; the changes which emotions produce in the heart beat are good examples of other changes which are none the less important because they do not lend themselves so readily to observation. The bestowal of a healthy attention upon the moral aspects of conduct is a legitimate and essential part of personal hygiene, and it is not too much to say that much of the ill-health from which men and women suffer is to be traced primarily to the absence of sound moral sense or to its abnormal or perverted development. Care and worry often cause weariness and loss of sleep which even diversion and muscular exercise cannot overcome. They seldom trouble the young, but as age advances they are sometimes inevitable. Efforts should be made to avoid them, as far as possible, by a wise ordering of life, by forethought, thrift, economy, sobriety, honesty, and the like, which tend to "a light heart" and "a clear conscience." A heavy heart and a clouded conscience tend not only to unhappiness and anxiety but also to loss of appetite, depression, wakefulness, and other physical ills.

13. "Mental cures" of disease. It has been shown that mental conditions have a direct influence upon the activities of the body, even leaving out of account the voluntary muscles. The effect of emotions upon the heart has been referred to, and so has the psychic secretion of gastric juice. It is known that the movements of the alimentary canal are readily modified by events in conscious life. In the hypnotic state the effect of suggestion upon functions which we habitually regard as involuntary is even more striking. Facts like these have led some to the rash assumption that there is no limit to the domination of the mind over physiological processes. Occasionally the ascendancy which some have gained over certain forms of disease has been as surprising to others as it has been gratifying to themselves. Beyond question the righting of disordered functions and the suppression of pain have been frequently attained, and this fact makes it easy to see why so great a following has been drawn to a belief in the unlimited possibilities of mental power.

Nevertheless certain dangers are always involved in the attempt to overcome disease by resolutely forgetting it and denying its existence. The feeling of pain may at times be banished by believing that it does not exist, *but this condition may be quite as undesirable as self-inflicted blindness or deafness.* While relief from pain may frequently favor recovery by promoting rest and nutrition, it may at other times simply mean the loss of warnings which deserve to be heard. Where there is grave organic disease, such as cancer, this may move on to a fatal issue even while the deluded subject consistently ignores or seeks to ignore its existence. It is not wise to try to annul the *effects* of a disease in consciousness when these effects *as well as their cause* can be removed by rational medical treatment. Hypnotism may relieve a toothache, but it is not claimed that it will mend a decaying tooth. The dentist's filling, which does both, is the type of medical as contrasted with psychical methods in dealing with acute disease. Especially foolish is it to ignore or deny the actual presence of infectious or contagious disease, for here delay menaces not only the patient but those about him. The consequences of this folly, when confined to its deluded victim, may end in virtual suicide; when they extend to others, they may fall little short of manslaughter.

CHAPTER XIX

THE HYGIENE OF FEEDING

The present chapter deals with certain hygienic considerations connected with the taking of food into the body — its preparation, its cooking, its quantity, the frequency of our meals, and the adjustment of our habits of feeding to the other work of life.[1]

Mankind as a whole was probably never better fed than it is at present. The opening up of the New World with its vast fields of corn and wheat and its enormous pastures; the introduction of improved methods of agriculture, agricultural machinery, and education in agriculture; and especially the improvements in transportation facilities and in arts of food preserving (such as refrigeration and canning), — all these have immensely increased the *available* food supply of the world and made famine and starvation much more rare than formerly. It is now only in inaccessible places, such as the central parts of India, that great famines still occur.

And yet in the midst of abundance it is still true that many men and women are poorly nourished, for it is the absorption of food by the blood and not merely the eating of meals which supplies the needs of the tissues. Hence the problem of alimentation in its widest sense involves not only the growing of food on farms or in gardens, and the preservation of this food so that it may be delivered in proper form to the consumer, but also the eating of it in such forms and

[1] Many practical points connected with alimentation have already been considered in Part I (see chapters on digestion and nutrition).

quantities and at such times as will insure its final utilization, after processes of digestion, for the needs of the body.

1. Appetite as a guide in feeding. Nature herself has provided us with guides in the choice of food, and these guides are the sensations of hunger and thirst and what we sum up in general under the term "appetite." So long as these remain normal and unperverted, they are to be largely trusted; and, like all physiological functions, they are kept normal and unperverted, in the first place, by attention to the *general health* of the entire body. Appetite is apt to fail or become untrustworthy in the case of men or women who are suffering from lack of muscular activity or from mental worry. The care of the appetite is rarely a matter of direct attention to the appetite itself, but only of maintaining bodily conditions in which it acts normally. Consequently the basic principle in securing proper nutrition is attention to the *general health.* A patient suffering from indigestion once consulted a wise old doctor and began recounting the foods that agreed or disagreed with him, together with his innumerable symptoms, until the doctor interrupted him by saying, "The first thing you must do is to forget that you have a stomach." The present chapter is not written for people like this patient, or for invalids, or for others suffering from indigestion in any one of its thousand forms. It is written for those who can and will, first of all, take the needful muscular exercise and the needful rest; who will pay proper attention to clothing and bathing, to the heating and ventilation of the home, to the avoidance of dampness and other unfavorable conditions; who will not abuse themselves by stimulants and narcotics. Those who prefer not to belong to this class, or who cannot do so because of some constitutional disease, must seek and depend upon medical advice as regards their habits of feeding.

At the same time, to insure proper digestion and nutrition more is required than attention to general hygiene.

What additional precautions are advisable in the taking of food by persons leading an otherwise healthy life? It is in answer to this question that we shall attempt to give some suggestions.

2. Good cooking an aid in nutrition. It has already been pointed out that digestion begins with the preparation of the food by cooking, which serves three purposes:

1. It destroys parasites and disease germs. The importance of this will be shown and emphasized elsewhere (Chap. XXXIV).

2. It renders the food more appetizing (see p. 115).

3. It makes some foods more digestible by making them accessible to the action of the digestive juices; thus the connective tissue of animal foods, when heated in the presence of water, swells and is more easily acted on by the gastric juice, so that tough meat in this way is often made tender by boiling. The cellulose walls of the vegetable foods, on the other hand, are softened by cooking, and the starch granules are swollen and their envelopes burst (see p. 97).

At the same time it is possible to render food less digestible by improper cooking. A piece of meat may "have the life cooked out of it," and egg albumen, which in the raw state mixes rather easily with the gastric juice, may sometimes be boiled to a leathery consistency which renders the action of the digestive juices a slow process.

3. Chewing of food an aid to digestion. We have seen that the word "digestion" is derived from the Latin words *dis* and *gero*, "to tear apart," or separate, and our studies of physiology have shown how the division of the food into very small masses by mastication facilitates access of digestive juices and so secures reasonable rapidity of solution and absorption. Proper attention to the teeth therefore becomes an important factor in the hygiene of alimentation. The structure and care of the teeth will be described in Chapter XXIII.

Another and probably equally important reason why food should be well chewed before swallowing is the prolongation thereby secured of its stay in the mouth, where it stimulates the afferent nerves of taste and so evokes the "psychic" secretion of the gastric juice. Food quickly swallowed does not afford as efficient a stimulus to gastric secretion as that which stays longer in the mouth. The refinement of much of our modern food may lessen the necessity for its subdivision by mastication, but not the necessity for this stimulation of gastric secretion. Starchy foods also receive a larger admixture of saliva when well chewed, and this facilitates the gastric digestion of starch. It is true that the "quick lunch" thrives in busy places, but no one considers it hygienic.

4. Feeding in relation to gastric digestion. In order that gastric digestion may be efficient it is of course necessary that gastric juice shall be secreted in proper amount, and we have learned that the first step toward this secretion consists in the agreeable sensations connected with the satisfaction of appetite. Consequently it is one of the first hygienic requisites of gastric digestion that the food shall be appetizing and that the condition of the body and, especially, of the digestive system shall be such that the food shall be eaten with relish. This is not the same thing as saying that food which is appetizing will be digested; it merely means that food is more digestible for being appetizing, and that when it is not enjoyed, its stay in the stomach is apt to be unduly prolonged. For this and other reasons the appetite should not be impaired by eating candy or by visiting the pantry between meals for something to eat; on the other hand, a good appetite should be encouraged by healthy living, by proper preparation of the food, and even, as far as possible, by agreeable table appointments. There was wisdom as well as pleasure in the old custom of having a jester at the dinner table, and there is reason in the saying, "Laugh and grow fat."

5. Excessive quantity of food; overfeeding. It is furthermore important that the amount of food eaten at one time be not excessive and that the stomach under no circumstances be unduly distended. A large proportion of those cases of dyspepsia which have their origin partly or entirely in the conditions of feeding are due to overeating, which may take various forms. Too large a proportion of the daily food may be taken at one meal, usually dinner; or too many meals may be taken — three should suffice; or each of the three may be full-sized meals — a very undesirable custom among those engaged in sedentary pursuits. We have seen that the one condition of life which calls for heavy feeding is that of muscular activity, whether in the performance of external work or for the production of heat in cold weather; a person who is engaged in any occupation which involves large amounts of muscular work doubtless should have three full meals daily; with others the habit is attended with considerable risk.

Gluttony has always been a vice of the idle and luxurious. As the world has grown wiser it has become less common, because a larger intelligence makes it plain that gluttony defeats its own ends and that the secret of the greatest pleasure in eating, as in everything, lies in temperance, not in excess.

Many persons, however, without any desire or even any thought of gluttony, regularly overeat. These are usually healthy persons leading sedentary lives, "blessed," as they say, "with a good appetite," and because of quiet or even indolent disposition giving but small heed to muscular activity. As the years go by, such persons are apt to grow fat and by and by to find themselves suffering from a weak heart, or shortness of breath, or something worse, seldom realizing, until it is too late, that overeating is the *principal cause* of their undoing. If sufficient manual labor or other exercise of the skeletal muscles is practiced, trouble from overeating rarely comes. It is the sedentary, inactive, and indolent who suffer most from this source; for them a good appetite often proves to be a curse rather than a blessing, and a poor appetite, by preventing overeating, has often been a blessing, though a blessing in disguise.

6. Fried foods. Caution is required in the use of fried foods. When a layer of fat varnishes over a particle of food the digestive juices do not readily penetrate the mass, and digestion is to that extent impaired. This is not of so much importance in intestinal digestion, since in that portion of the alimentary canal the layer of fat is itself digested and removed; the stomach, on the other hand, does not digest fat, and we can easily see how, because of its interference with the first processes of digestion in this organ, the use of too much fried food is unwise.

Moreover, in frying, care should be taken to have the temperature of the fat high enough to coagulate promptly the surface layers of the food, thus preventing the penetration of the fat into the food, which, however, should not be served swimming in fat, but as dry as possible. The frying pan is still used far too extensively in some parts of America. Most of our foods should be roasted, broiled, boiled, or baked, rather than fried.

7. Perspiration in relation to the hygiene of feeding. The secretion of gastric juice is seriously impaired by excessive perspiration, especially when the loss to the system is not made good by drinking sufficient amounts of water. This is probably true of the secretion of all of the digestive juices, but it is especially important in the case of the gastric digestion, upon the proper performance of which the subsequent work of intestinal digestion so largely depends. Therefore, in general, smaller meals should be eaten in hot weather, — we have seen that we need less food at that time, — and heavy meals should not be taken immediately after vigorous exercise involving profuse perspiration. Indeed, it is a general rule that excessive loss of water by perspiration should be made good, as far as possible, by drinking water more freely.

8. Digestion and bodily fatigue. Digestion, like all other functions of the body, involves to a very considerable extent the intervention of the nervous system, and we may repeat here the advice already given (p. 332), not to go tired to the digestion of a heavy meal. It is one of the objections, probably the chief objection, to evening dinners that they so frequently follow immediately upon a hard day's work, when the nervous system is in a poor condition for its share in digestive work. A rest of half an hour before dinner is, however, generally all that is needed, and usually prevents the mental heaviness which so often follows a full meal.

9. Mental work after meals. An exaggerated importance has probably been given at times to the danger of mental work after meals. There is no proof whatever that the demand of the brain for greater blood supply will seriously interfere with that to the digestive organs. While it is true that indigestion often affects people who go straight from their meals to hard mental work, it is also true that these are usually people who take insufficient muscular exercise, rest, and sleep. The relation of the circulation in the brain to that in the digestive organs is too imperfectly understood to justify some of the glib but shallow utterances frequently met with on this subject, especially when the statements in question are not clearly supported by experience (see p. 157).

10. Muscular activity after meals. Vigorous muscular activity immediately after meals is quite another matter. Here we know that blood is taken away from the digestive organs and sent through the muscles and skin; this fact suggests caution, and experience amply confirms the need of the caution thus suggested. Even here it is *vigorous* exercise, and especially after *heavy* meals, that is to be avoided.

11. The use of water as a drink. Many people, and especially many women, drink too little water. Water is constantly being lost through the lungs, skin, or kidneys, and this loss is only partially made good by the oxidation of the hydrogen of the proteins and fats.[1] No rules as to the amount can be given, since it varies so much with temperature and the amount of muscular activity; but the habit of drinking no water between meals and but little at the table, in spite of popular opinion on the subject, is open to grave objections. We have already shown that the abstraction of undue amounts of water by perspiration may seriously interfere with the secretion of the gastric juice, and there is every reason to believe that a deficiency in the supply of water to the blood similarly interferes with the secretion of the other digestive juices and so, by impairing intestinal digestion, favors constipation.

Much emphasis has been laid upon the danger of drinking water with meals. The reasons given — that water unduly dilutes the gastric juice or takes the place of a normal secretion of saliva — are questionable. As a matter of fact, the water thus taken is soon passed on into the intestine and absorbed. It is true, however, that the use of too much liquid with a meal is apt to lead to insufficient mastication because it makes it easier to swallow the food; and from this point of view caution is advisable. It is certainly also true that much drinking with meals tends to overeating, by facilitating *rapid* eating; and it may be that this is one reason why fat people are usually great drinkers. They "wash down" too much food.

A further point in the hygiene of gastric and intestinal digestion is the avoidance of those inflammatory conditions of the bowels which follow exposure to cold. This subject

[1] The water excreted from the body comes partly from the water drunk, but also partly from that formed by the union of the hydrogen of the food with oxygen.

will be dealt with in Chapter XXI. The student will also recall what has been said in Chapter XVII with regard to the importance of general muscular exercise and, especially, of exercises involving the use of abdominal muscles.

12. The value of indigestible material in food. The importance of having a certain amount of indigestible material (mostly cellulose) in the food has long been emphasized in dietetics, and many people undoubtedly find this a valuable aid in securing proper digestion of the food and, especially, in avoiding constipation. The exact mode of action of these indigestible wastes is not clear. They unquestionably add a certain bulk to the contents of the large intestine, and this would aid in stimulating the intestinal movements. It has also been supposed that the contact of solid particles with the mucous membrane of the intestine acts as a stimulus to the intestinal movements, although this view lacks any clear experimental support. A third suggestion is that the solid indigestible waste "scours" the wall of the intestine clean of tenacious material, such as mucus and bile pigments, just as a floor may be more effectively cleaned by sprinkling wet sawdust over it before sweeping.

Whatever the mode of action, there can be little doubt that we have in fruit, oatmeal, graham bread, lettuce salad, and many fresh vegetables, foods whose indigestible residue often contributes to more effective digestion; and the regular inclusion of such coarse foods in the diet, especially in winter, is advisable.

13. The elimination of intestinal waste. Those who are "blessed with a good digestion" sometimes find it hard to realize that the preparation of food for absorption from the alimentary canal involves the coöperation and fine adjustment of much delicate physical and physiological apparatus.

Let us then remember that the efficient handling of the food in the stomach is aided by the preparatory crushing it receives in the process of mastication; that in the stomach an adequate and efficient secretion of gastric juice must take place, and that this begins as the result of nervous events connected with our enjoyment of the food when eaten; that the continued secretion of gastric juice is secured, in turn, by stimulation of the mucous membrane of the stomach by the peptones which the psychic secretion has formed from the proteins of the food; and, finally, that the chemical action of the gastric juice is aided by the peculiar contractions of the muscular coat of the stomach. All these agencies *working together* deliver the food to the intestine in a finely divided state, well adapted and indeed absolutely necessary to secure the proper contact of the food with the pancreatic juice, the bile, and the intestinal juice.

The flow of pancreatic juice, in turn, is partly the result of the action of the hydrochloric acid of the chyme on the walls of the intestine, while the efficiency of the action of the pancreatic enzymes depends upon the simultaneous action of the bile and the intestinal juice; lastly, the chemical action of these juices, as well as the final act of absorption, requires the coöperation of the muscular coat. Healthy conditions with respect to bacterial action similarly depend upon all else occurring as it should. *Digestion, in short, is a chain of events*, each depending upon those which have gone before and, to a large extent, upon those which are taking place at the same time.

Keeping these facts in mind, it is easy to appreciate the possibility of diarrhea or constipation, the latter consisting in the retention of wastes, the poisonous constituents of which may be absorbed into the body and cause discomfort, headaches, and malaise. When all the digestive processes work together properly, there should be a perfectly natural and regular evacuation of the bowels. The frequency of such evacuation varies somewhat and is largely a matter of habit; with some people it is twice a day, with others once every other day, *but with the vast majority it is normally once every day and at about the same time.* Where this is not the case, there is reason to believe that some part of the work of digestion is not being properly performed. The trouble is not ordinarily in the mechanism governing the actual discharge of the feces from the rectum, but in a derangement somewhere else; it may be entirely the fault of the mechanism of peristalsis, or it may be due to imperfect secretion. In all cases it means that *something is wrong*, and the remedy should be sought not in drugs or pills but in search for and *removal of the cause.* A moment's consideration will show the reasonableness of this position. If a watch loses time because it needs cleaning, we do not seek a remedy in drugs, but in its cleaning, better adjustment, and good care; and the remedy for diarrhea or constipation should in all cases be sought for in the better conduct of life. Is enough muscular exercise being taken? Is the diet properly chosen? Are we drinking enough water? Especially, is the food of sufficient bulk and does it contain enough laxative material (such as fruit)? Above all, are we getting enough sleep? Are we overworking, or do we work too long at a time without resting? Is our clothing warm enough, or are we overclad? Such are the questions which should be seriously asked. The student of personal hygiene cannot lay to heart too seriously the truth that the man who goes from day to day, from week to week, from year to year, neglecting the warnings of diarrhea or constipation, only reaps the harvest of his folly when in later years he suffers loss of health and at times bodily discomfort; and it is nothing short of impiety to marvel, under such circumstances, at the "mysterious" ways of a Providence which so "afflicts" his creatures. It is no exaggeration to say that the regular discharge of the wastes is quite as important as the regular feeding of the body, and that no less pains should be taken to form good habits in the one case than in the other. Many of the headaches, many of the bad feelings, and many of the bad tempers of the world are due to neglect of this simple fact. No city, however well fed or beautiful, the drains of which are choked with filth, can long remain either wholesome or attractive; and the human body is essentially a city teeming with living cells.

14. The individual must study his own needs. In thus sketching the broad outline of hygienic feeding, little or no attention has been given to what we should or should not eat; and this has been done intentionally in order to discourage the reader from looking at the subject from this popular but too often misleading point of view. It may be true that "what is one man's meat is sometimes another man's poison," but only in a very limited sense. Each individual in the course of his experience will learn that there are some things he cannot eat with impunity and others that he had better not eat. He will find himself growing fat or growing thin, he will find his powers of digestion good or bad, he will experience comfort or discomfort after eating, and if he is wise he will govern himself accordingly. But it must be remembered that man enjoys a wide latitude in the choice of his food. The vast majority of people, if they will but lead otherwise hygienic lives, can eat almost any food; and the inability to digest something which we have always eaten or which others eat with impunity should lead not so much to its exclusion from the diet as to an inquiry whether the trouble does not have its origin in the general unhygienic conduct of life. Those who treat such conditions by constructing a table of the things they can eat and another of those they cannot eat, and confine their diet to the former, usually find that as life advances, the size of the latter table increases at the expense of the former. It is the fallacy of dealing superficially with the symptom instead of the disease, — the same fallacy which leads to the treatment of constipation with cathartics and bronchial coughs with cough medicines.

CHAPTER XX

FOOD ACCESSORIES, DRUGS, ALCOHOL, AND TOBACCO

1. Food accessories and drugs. Through the alimentary and respiratory tracts there are received into the blood not only substances such as proteins, gelatin, fats, carbohydrates, salts, and water, which we have described as supplying the material for power and for growth and repair, but also other substances capable of modifying in one way or another the course of events within the body. The flavors which contribute to the enjoyment of foods play an important rôle in the secretion of the gastric juice, and yet the substances which cause these flavors are negligible as sources of power. Salt belongs under the same head, for we use in cooking more salt than is needed to make good the daily loss from the body, and we do this to develop an agreeable flavor in our food. Substances of this kind are spoken of as *food accessories*, and among them must be included coffee and tea, for their effect is not chiefly a matter of nutrition; certain constituents of tea and coffee absorbed into the blood affect the nervous system, and it is largely for this reason that we use them.

We may pass in this way from the necessary food accessories through those, like coffee and tea, which, while not essential, may still be regarded as part of the food of a large portion of mankind, to the great number of chemical compounds known as *drugs*, which also act by changing the course of events within the body; and it is difficult to draw any sharp line of distinction between those which occasionally serve as medicine or "stimulants" and those of which daily use is made as food accessories.

Animals as a rule take substances into their bodies only to satisfy hunger or thirst or appetite; man alone takes, in addition to his nutriment, food accessories and drugs for the sake of their special effect upon the nervous system or other organs. Many of the numerous food accessories which human ingenuity has discovered or devised are harmless enough in the form used, but others contain substances which are capable of poisoning the body. It is an important part of the study of personal hygiene to learn of what these substances consist, what is their action on the human organism, and wherein lie their special dangers.

2. The drug habit. It is a lamentable fact that large amounts of drugs are swallowed by men and women apart from any medical need which compels their use. In a subsequent chapter we shall show reasons for avoiding an undue dependence upon drugs as a remedy for various minor ills. Bad as this practice is, with its tendency to rely upon the uncertain action of a drug instead of taking proper hygienic care of the body, it is far worse to make habitual use of drugs for their special effects upon the healthy body, for the habit is one which is only too easily cultivated. There is no reason why a healthy human being, living a normal life amid healthful surroundings, should need to use drugs habitually, and a little consideration will show that the practice is dangerous.

3. Dangers of the drug habit. When we eat meat or vegetables, or when we breathe air, we take into the body materials needed for normal living. These things have always formed part of the food of the race and, unless wrongly taken, do good and not harm. When, on the other hand, we take a drug, such as chloroform, or cocaine, or opium, or alcohol, or coffee, or tea, we take something which is foreign to the body, in so far as it has not been a regular constituent of animal food in the past. It is not needed, as protein and salt and water are needed; there is no special preparation for its reception; and while it may do good, there is danger that it may do harm.

In the second place, the exact action of many drugs is only imperfectly understood. In an emergency the physician uses them *temporarily*, for some effect which he desires to produce, thus tiding over a difficulty. He uses the drug only a few times, at most, and is consequently not greatly concerned about unfavorable attendant effects; it accomplishes some needed purpose, and if it does any harm, the organism may be trusted to recover from it. It is very different, however, with the *habitual* use of any drug. The very fact that it gives some new direction to the events taking place within the body means that abnormal conditions of life are being maintained, and we have already learned that abnormal conditions of life are apt to be unhygienic.

Again, the use of drugs is only too apt to be substituted for the hygienic conduct of life. We may, for example, take drugs to accomplish something which the healthy body should accomplish for itself without outside help. When one drinks a cup of black coffee to facilitate mental work which his fatigued condition would not otherwise allow him to do, he is trying to get from a drug the power which he could and probably should secure by normal sleep. The coffee acts like a whip to a tired horse; the same work is done as might have been done had the horse been allowed a little rest, but the horse is not as well off when he does the work under the lash as when he does it in a properly rested condition. Similarly, persons suffering from sleeplessness often take drugs used to produce sleep (hypnotics), and, superficially at least, the sleep thus secured resembles normal sleep; but experience shows that few if any hypnotics can be used for any length of time without bad effects. Here again a drug is being depended upon to do what the normal body should do for itself. Pepsin tablets may be taken to aid digestion, and thereby an attack of indigestion may sometimes be prevented or relieved; but a healthy stomach should furnish its own pepsin, and the fact that it does not do so is a sure warning that something is wrong in the conduct of life. It is irrational to neglect the duty of attending to the cause of the ailment, and it is foolish to substitute temporary relief for permanent cure. Perhaps if the drug did *all* that the proper care of the body does, *and did no more*, no serious objection could be made to its use; but there is probably no drug of which this is true, and for this reason it is foolish and rash to try to substitute the use of drugs for the hygienic conduct of life.

Lastly, if the drugs do not accomplish in the long run what should be done by the hygienic conduct of life, their extensive use becomes all the more dangerous in view of the unquestioned fact that we are apt thereby to become their slaves. Every man is the slave, broadly speaking, of the habits he forms, and it is only a question as to whether he will be the willing slave of good habits or the abject slave of bad habits. The man who leads a hygienic life is the slave of muscular activity, of correct feeding, of proper clothing, of rest, etc.; that is to say, these things become necessary to his life; he cannot get along without them. If for these proper agents of health he persistently substitutes some drug, whether it be alcohol, or tobacco, or coffee, or tea, or chocolate, or opium, the habit of using the drug is substituted for that of maintaining normal conditions. But since drugs cannot *entirely* take the place of such conditions, the constitution goes from bad to worse, and increasing dependence must be placed upon the drug. It is a safe rule that whenever we are uncomfortable or unhappy without the use of a certain drug we should cease using it until, with the help of hygienic living, we can get along without it.

There are people who are slaves of coffee, of tea, of chocolate, of patent medicines, of candy, and of soda water just as truly as there are slaves of tobacco, or of alcohol, or of opium. It is worse to be the slave of alcohol than of coffee, because the evil consequences of alcohol are greater than those produced by the corresponding use of coffee; but it is by the same process in both cases that the man or woman becomes a slave to the drug, and that process is the formation of bad habits.

With these practical considerations about the use of drugs — by which term it will be seen that we mean not simply the medicines purchased from the apothecary but all those substances which are taken into the body in order to give some new or abnormal direction to the course of events in the organism — we may pass on to the discussion of those in common use.

4. Tea and coffee. Different as are these drinks in taste and appearance, their most important physiological effects are due essentially to the same substances; namely, *caffeine* (or theine) and *tannic acid* (or tannin). Caffeine is a very powerful stimulant, especially of the nervous system and also of the heart, although probably to a lesser degree; tannin, on the other hand, is a bitter, astringent substance, which may considerably hinder digestion and directly injure the mucous membrane of the stomach. Tea contains about twice as much tannin as an equal weight of coffee, but as coffee is frequently made much stronger than tea, the actual amount per cup may often be more nearly equal in the two drinks than these figures indicate. The amount of tannin dissolved in tea varies greatly with the method of preparation, and largely for this reason tea should not be boiled nor allowed to steep too long. The proper method of making tea is to pour over the dry leaves water which has been brought just to the boiling point and then to allow the infusion to stand, without further heating, for not more than a few minutes.

Both tea and coffee seem to have a slightly retarding influence upon gastric digestion. In healthy people this is of little consequence, but when the digestive powers are in any way impaired, the use of these beverages may be inadvisable. The more important effect, however, of both tea and coffee is in their stimulating action on the nervous system. No satisfactory explanation has yet been given of the fact that some people can use tea and not coffee, while with others the reverse is true. It is probably safe to say that when used in moderation, tea and coffee are usually harmless to those leading an otherwise hygienic life. They should be used sparingly by nervous people and by those in whom digestion is feeble and slow (Hutchinson). Even by the perfectly healthy they should not be used to excess, nor should the habit be acquired of using them as the whip to the tired horse. Drinking strong coffee in order to keep awake for evening study is objectionable, and the substitution of afternoon tea for a little rest or sleep is also unwise.

5. Cocoa is made from the seeds of trees of the genus Theobroma, and *chocolate* is prepared from cocoa. In the solid form both are highly nutritious, as shown by the following average results of analyses:

	PROTEIN	FAT	CARBOHYDRATE
Cocoa	21.6%	28.9%	37.7%
Chocolate	12.9%	48.7%	30.3%

When used as a beverage, however, the nutriment derived from them is small. In addition, cocoa and chocolate both contain *theobromine*, a substance closely related chemically to caffeine and possessing much the same stimulating properties. In general, the same hygienic considerations which apply to the use of tea and coffee should guide us also in the use of chocolate and cocoa.

6. Soda water and similar beverages. Of these little need be said. In general, they are harmless enough, especially to those enjoying perfect digestion. The large amount of sugar which they contain is apt to make matters worse in many cases of dyspepsia; by taking them frequently between meals the appetite for wholesome food is impaired, and excessive indulgence in them under any circumstances is needless and foolish.

7. Alcoholic beverages. In the case of an alcoholic drink we have to deal with something which, like tea and coffee and cocoa and "temperance drinks," is used as a beverage, and to that extent must be classed in the same group. Alcoholic drinks are, however, taken as stimulants and so resemble tea and coffee and cocoa, but they differ from all of these in their action upon the body. Moreover, their abuse gives rise not only to degraded moral and social conditions, but is also attended with bad hygienic effects. Everyone should be informed of their nature and of the dangers attending their use.

The common alcoholic beverages consist of (1) *malt* liquors, including beer and ale; (2) *wines*, such as hock, claret, Burgundy, sherry, and champagne; (3) *distilled* liquors, including brandy, whisky, rum, and gin; and (4) liqueurs and cordials. These groups are distinguished from one another largely by the method of preparation and by the amount of alcohol they contain. Malt liquors are fermented liquors which contain from three to eight per cent of alcohol; wines are also fermented liquors, but contain from seven to twenty per cent of alcohol; distilled liquors, on the other hand, are first fermented and then concentrated by distillation, and contain from thirty to sixty-five per cent of alcohol. In all these the most important constituent, so far as their physiological action upon the body is concerned, is the chemical compound known as *ethyl alcohol* (C_2H_6O or $C_2H_5 \cdot OH$).

8. Fermentation. The ethyl alcohol in each of these beverages is produced by the action of yeast on sugar, and this action is known as alcoholic fermentation. Yeast is a unicellular plant, and when a small amount of it is added to a solution of grape sugar or fruit sugar, it breaks up these substances, chiefly into alcohol and carbon dioxide gas. The latter passes off, while the alcohol remains behind in the solution. In addition to these chief products of fermentation there are always formed other products in small quantities, and to these, in part, the flavor of the fermented mixture is due. Different varieties of yeast produce different kinds of fermentation. Thus one variety (domesticated yeast) is used in making beer, and another (wild yeast) in making wine. The amount of alcohol produced differs with the yeast used, as do also the character and quantity of the secondary products. The growth of yeast, like that of all living ferments, is checked by the accumulation of the products of its own activity. Consequently when the alcohol produced reaches a certain percentage (usually less than ten per cent) the fermentation ceases. Alcoholic drinks which contain higher percentages of alcohol are prepared by special processes, which will be described later.

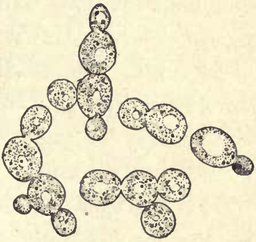


FIG. 117. Yeast cells

9. Malt liquors. Malt consists of sprouted grains (chiefly barley). The grains contain a large amount of starch which during the process of germination is converted into sugar by *diastase*, an enzyme produced by the living cells of the plant — the action of diastase being essentially similar to that of the ptyalin of the saliva. The germinating plant thus comes to contain considerable quantities of sugar, together with salts, proteins, and other substances. The watery extract of malt is known as *wort*, and it is this which, after being boiled with hops, is acted upon by the yeast. The liquid thus produced from wort by fermentation is known as ale, beer, stout, porter, etc., according to the conditions under which the fermentation takes place and the character of the malt and the yeast employed. German beers contain from three to four per cent of alcohol; ale contains from four to six per cent.

10. Wines. Wine is produced by the fermentation of the juice obtained by crushing grapes, and the yeast comes from the "bloom" on the skin of the grapes. The juice, or "must," thus extracted is allowed to undergo fermentation, and the fermented liquid is wine. Most wines, however, are subjected to subsequent treatment. Some are allowed to ripen in wooden casks, during which process there take place chemical changes which give to each wine its peculiar flavor. In other cases the wine is "fortified" by the direct addition of alcohol. Wines differ from one another according to the variety of the grape used in making the must, according to the variety of yeast used for fermentation, and according to other circumstances.

11. Distilled liquors and spirits. This group of alcoholic beverages contains the highest percentage of alcohol, and includes whisky, brandy, rum, and gin. In the making of all of these the essential procedure is the same; namely, first to produce fermentation in some sugary liquid and afterwards to *distill* from the products of this fermentation its alcohol and some other volatile constituents. Whisky is made by distilling fermented corn or rye; brandy may be spoken of as distilled wine; rum is distilled from fermented molasses, and gin from a fermented mixture of rye and malt — juniper berries and other substances being added to the distilled product. In general, distilled liquors contain from thirty to sixty per cent of alcohol.

With these differences of preparation, alcoholic beverages differ greatly among themselves, independently of the quantity of alcohol they contain, and some of their special effects are due to other constituents. The *chief danger* of most of them, however, lies in the action of the ethyl alcohol upon the system, and we shall confine our discussion to the effects of this substance. The problem is by no means a simple one, because these beverages are used in so many different ways by different people. Moreover, the results of their use differ according to the constitution of the person using them and according to his other habits of life. Sweeping assertions are too frequently made, in good faith, only to be found false by experience in special cases, and in this way harm is done where good was intended. For example, it is often asserted that alcohol used in any amount whatever is a poison to the healthy organism. If this be so, it is the only known drug of which this is true. Dr. John J. Abel, from whom we shall extensively quote, says on this subject: "All poisons are capable of being taken without *demonstrable* injury in a certain quantity, which is for each of them a special though sometimes very minute fraction of their toxic or lethal dose. There is no substance which is always and everywhere a poison." Alcohol is a drug and, like many drugs, may be and frequently is used in poisonous doses, but it must not be supposed that its real danger lies in the fact that it always exerts a poisonous effect on the body.

12. The physiological action of alcohol. As to the immediate action of alcohol on the body we may say that it belongs in the same general class of drugs as the ether and chloroform used for anesthesia; in other words, its general action is that of a *hypnotic* or *anesthetic.* To quote again from Dr. Abel:

An exhilarating action is an inherent property of these substances in certain doses. Occasionally the physician meets with persons who have formed the habit of inhaling chloroform from the palm of the hand or from a lightly saturated handkerchief. The inhalation is usually carried on for a short time only, and its object is to induce a pleasant form of mental stimulation. Only occasionally is the inhalation of chloroform carried on until helpless intoxication occurs.

And again:

> That alcohol can produce as profound anesthesia as any of the substances named is also well known. In the days before anesthesia it was the custom of bone setters to ply their patients with alcohol in order to facilitate the reduction of difficult dislocations. . . . The anesthesia produced by alcohol is, however, not commendable, since it cannot safely be induced in a short time and is too prolonged. The quantity needed for surgical anesthesia would in many cases lead to a fatal result.

13. Is alcohol a stimulant? The view of the action of alcohol just stated is, of course, borne out by the condition of a thoroughly intoxicated person; but it is opposed to the very general idea that alcohol, except in large doses, is to be regarded as a stimulant. Whether we shall call it a "stimulant" or not depends upon how we use that term. Some of the exhilarating effects of alcoholic drinks might lead us to speak of it in this way. People who have drunk wine often become more talkative, so that the first effects of intoxication often resemble those of stimulation. There is, however, strong reason for thinking that this action is only superficially, and not fundamentally, a case of stimulation, as we shall now see.

In studying the physiology of the nervous system we found that processes of *inhibition* are as important in its operation as are those of *excitation*; and in mental operations the course of our thinking is constantly checked or inhibited by the knowledge of facts opposed to the conclusions towards which we are tending. *Probably it is this essential feature of all accurate and valuable mental work which is the first to be paralyzed by alcohol.* The man who takes alcohol becomes fluent not because he is stimulated but because of the removal of checks whose presence may make him talk less fluently, but which at the same time make him speak more accurately. He may become witty, and may say some brilliant things, but he will almost always do and say some very erratic things.

The following (by Dr. Abel) appears to be a sound statement of our present knowledge of this important subject:

Alcohol is not found by psychologists to increase the quantity or vigor of mental operations; in fact, it clearly tends to lessen the power of clear and consecutive reasoning. In many respects its action on the higher functions of the mind resembles that of fatigue of the brain, though with this action is associated a tendency to greater motor energy and ease.

In speaking of a certain type of individual James says: "It is the absence of scruples, of consequences, of considerations, the extraordinary simplification of each moment's outlook, that gives to the explosive individual such motor energy and ease." This description aptly applies to the individual who is under the influence of a "moderate" quantity of alcohol. It tends to turn the inhibitive type of mind into the "hair-trigger" type. We have said that the speech and the bearing of men, the play of their features, all bear witness to the action of alcohol on the brain; that it removes restraints, blunts too acute sensibilities, dispels sensations of fatigue, causes a certain type of ideas and mental images to follow each other with greater rapidity, and gives a "cerebral sense of richness."

Larger quantities, such as are for most individuals represented by one or two bottles of wine (ten per cent of alcohol), may, according to the resistance and type of individual in question, cause a lack of control of the emotions; noticeably affect the power of attention, of clear judgment and reason; and decidedly lower the acuteness of the several senses. In many individuals such quantities will develop so marked an anesthetic action that all phenomena of intoxication may be seen to follow each other in due sequence, finally to end in the sleep of drunkenness.

There has been much discussion as to whether alcohol is in any sense a stimulant for the brain. We have seen that pharmacologists of high repute deny that it has this action, holding that alcohol is a sedative or narcotic substance which belongs to the same class as paraldehyde and chloroform; that its stimulating action is but fictitious; and that even the earlier phenomena of its action are to be referred to a paralyzing action on cerebral (inhibitory) functions. This theory assumes an unequal action on cerebral functions in the order of time. Kraepelin, however, holds that this is a purely subjective analysis, and that in the early stages of its action alcohol truly stimulates the motor functions of the brain; that a state of mental exhilaration, of "motor excitability," may coexist with undiminished power of perception and judgment. His psychological experiments on the action of alcohol, taken all in all, do not, however, entirely prove his position.

Some cases of apparent stimulation are really due to the fact that alcohol, when taken in the form of wines and distilled liquors, sets up an irritation in the mucous membrane of the mouth, œsophagus, and stomach, which *reflexly* excites the heart to greater activity or for the time being *reflexly* stimulates the nervous system. Such stimulation is, however, transient and, as the alcohol is absorbed into the blood, gives way to depression and even stupor.

It is neither possible nor necessary to state here in full the reasons which have led to what seems to the authors the erroneous view that alcohol in small doses is a stimulant and only in larger doses a depressant and hypnotic. Enough has been said to show that there are at least two opinions about the matter: that even if alcohol is at times a stimulant, it is an uncertain stimulant, and that its excitation is liable to give way at any time to depressing effects. A critical examination of the literature on the subject has failed to demonstrate to us a direct stimulating action of alcohol on any of the functions, such as the beat of the heart, respiration, digestion, etc. At times, especially in sickness, alcohol may be useful; but the evidence tends to the conclusion that where it exerts any physiological action on the healthy body at all, that action is usually depressing. This is notably true as to the beat of the heart, as to respiration, and as to the ability to do muscular work.

We have dwelt at length upon this question in order to disabuse the student's mind of the idea that alcoholic drinks can be safely depended upon as an aid in the performance of work. Few causes are more effective in leading to the abuse of alcohol than the idea that when one finds difficulty in doing a thing it may be accomplished more easily by having recourse to beer or wine or whisky for their "stimulating" effect. In general, so far is this from being the truth that the person seeking such aid is really using a hypnotic and depressant. Obviously he would be acting more wisely to adopt other methods of accomplishing his end. Nor is this conclusion merely theoretical. Brain workers who wish to "keep a clear head" almost universally avoid alcoholic drinks, at least until work is over.

14. Alcohol in muscular work. That the general effect of alcoholic drinks is to depress rather than stimulate the powers of the body is furthermore indicated by the results of experiments on men doing heavy work, as, for example, soldiers on forced marches. In the Ashanti campaign the effect of alcohol as compared with beef tea was tested. To quote from Sir Lauder Brunton:

> It was found that when a ration of rum was served out, the soldier at first marched more briskly, but after about three miles had been traversed the effect of it seemed to be worn off, and then he lagged more than before. If a second ration were given, its effect was less marked, and wore off sooner than that of the first. A ration of beef tea, however, seemed to have as great a stimulating power as one of rum, and not to be followed by any secondary depression.

The results of these and other experiments lead us to the conclusion that alcohol cannot be depended upon to increase the capacity for hard muscular work and that in the great majority of cases it actually diminishes it.

15. The dilation of cutaneous arteries by alcohol. One of the most important effects of alcoholic drinks is the dilation of the arteries of the skin, thus sending more warm blood to the surface. It is a common experience among persons not accustomed to alcoholic drinks that even a small amount "makes the face hot" and flushed, and the red face of the toper is proverbial. The result of this dilating effect is that the temperature of the skin rises and the individual feels warmer. Congested states of internal organs may thus be relieved, and this is probably one reason why men leading an exclusively sedentary life often use alcoholic drinks apparently to some advantage. But even these would do infinitely better to secure the same result by proper muscular activity.

Even if a temporary advantage appears to be gained in some cases or at some times, this has often to be paid for by bad secondary effects, such as impaired capacity for good work some hours later; and in mental work of the highest kind, such as original writing or composition, the after effects of alcoholic drinks are sometimes prolonged and easily detected by the subject of the experiment.

16. Alcohol as a defense against exposure to cold. Because of this effect upon the cutaneous circulation alcoholic drinks are frequently used by men exposed to cold, with the mistaken idea that the conditions within the body are thereby improved. The student has, however, learned (p. 193) that a *feeling* or *sensation* of warmth does not necessarily indicate greater heat production within the body; and he also knows that bringing the blood to the skin when the body is exposed to cold serves to increase the loss of heat. As a matter of fact the internal temperature often falls when alcohol is taken under these conditions. The story is told of some woodsmen who were overtaken by a severe snowstorm and had to spend the night away from camp; they had with them a bottle of whisky, and, chilled to the bone, some imbibed freely, while others refused to drink. Those who drank soon felt comfortable and went to sleep in their improvised shelter; those who did not drink felt very uncomfortable throughout the night and could get no sleep, but in the morning they were alive and able to struggle back to camp, while their companions who had used alcoholic drinks were found frozen to death. They had purchased relief from their unpleasant sensations of cold at the cost of lowering their body temperature below the safety point. This, if true, was, of course, an extreme case; but it accords with the universal experience of arctic travelers and of lumbermen and hunters in northern woods, that the use of alcohol during exposure to cold, although contributing greatly to one's comfort for the time being, is generally followed by undesirable or dangerous after effects.

17. Alcohol as a food. There has been much discussion as to whether alcohol is or is not a food; that is, whether its oxidation within the body may supply energy. This question must now be answered in the affirmative, although whether it can do more than supply heat to maintain the body temperature, — that is, whether it can also supply the power for muscular work, as do fats and carbohydrates, — we cannot in the present state of our knowledge positively say. In many cases of sickness the oxidation of alcohol is probably a useful source of heat production, since it is absorbed quickly and without digestion, but the healthy man does not and should not use it in this way. The amounts which would be required to be of any considerable service as food are far beyond those in which it may be used with safety. In other words, in using alcohol for food one would be obtaining heat at the cost of direct injury to many organs and also at the cost of impaired working power. Moreover, men do not use alcohol as a food; they use it as a drug. So that while the action of alcohol as a food is of practical importance to the physician, who must deal with the abnormal conditions of disease, its action as a food is not a matter of practical importance to healthy people.

18. Pathological conditions due to the use of alcohol. When alcoholic beverages are taken in excessive amounts we have the sad and degrading spectacle of a "drunken spree." Whether or not the drinker at first appears bright or witty, sooner or later there is presented the pitiable picture of complete loss of nervous coördination and control. The man becomes silly, or maudlin, or pugnacious, as the case may be, but always irrational; he staggers, stumbles, or falls; and finally passes into a drunken stupor. In this event the victim of his own indulgence is said to be "dead" drunk, or "intoxicated," being as it were thoroughly *poisoned.* If such intoxication is frequently repeated, there is a complete breakdown of the nervous system; the victim of alcoholic indulgence becomes a raving maniac and, with disordered vision, thinks he sees all about him snakes or foul vermin (*delirium tremens*). The silly or foolish stage of this poisoning sometimes provokes smiles or laughter in thoughtless observers, but none can witness the more serious consequences of repeated intoxication by alcoholic drinks without disgust and horror.

Many steady drinkers, even though they have never been drunk in their lives, are apt ultimately to acquire various diseased conditions of the body, into which we cannot enter in detail. The heart may be injured, or the arteries become diseased; the repeated irritation of the stomach may produce chronic gastritis; or the connective tissue of the liver and kidneys may increase, thus crowding upon the living cells and ultimately throwing a large part of them entirely out of use. While it must not be supposed that drinking alcohol is the sole cause of these troubles, — for some or all of them may come from other causes, — the frequency of their occurrence in steady drinkers is suspiciously high, and this has led to the very strong conviction among medical men that alcohol plays a large rôle in producing them.

19. Summary of the action of alcohol as a drug. In small doses alcohol may be completely oxidized within the body without exerting any pharmacological action. In the forms and amounts usually employed in alcoholic beverages it exerts, *in general*, a hypnotic or anesthetic action; the result on the system as a whole depends on the amount taken, and varies from the paralysis of inhibitory processes to the depression of all nervous functions, ending in drunken stupor. Continued excess may produce exaggerated forms of temporary insanity, among which delirium tremens may be mentioned. There is, moreover, good reason for believing that steady drinking is very frequently an important agent in preparing the way for many other diseases, and is hence a serious menace to health.

20. The seat of the danger in alcoholic drink. The regular use of alcoholic beverages is dangerous for the same reason that the regular use of any drug is dangerous. We are too apt to rely upon the drug to do for us what we ought to accomplish only by the hygienic conduct of life; the drug never satisfactorily does the work, and we go from bad to worse, and become its slave. But there is certainly greater danger in hypnotic drugs, like alcohol, than in true stimulants, like coffee, and cocoa, and tea. We need to have ourselves well under control when we use any drug; the highest faculties of the mind must keep tight rein or we may lose control of ourselves. With hypnotic drugs — to which class belong not only alcohol but ether, chloroform, opium, chloral, etc. — there is special danger that these powers of control (inhibition) may be stealthily paralyzed before we know it. Of course thousands of people use alcohol in moderation and never become drunkards; but thousands also, with no intention of using it to excess, do unconsciously let the reins drop, and before they know it the drug gets the better of them. Experience shows that it is with the hypnotic drugs that this most frequently happens.

Again, if we make a habit of taking alcoholic drinks, we are specially exposed to temptation from our fellow men to go too far. For the most part, people take coffee and tea or do not take them, as they please; no one urges them to use these drinks when they are disinclined to do so. To a less degree the same thing is true of tobacco, although here the force of fashion and example is stronger. But with alcoholic beverages the custom of "treating" makes the exercise of self-restraint more difficult than it would otherwise be, for here we are dealing with a drug which is capable of *impairing self-control.* Some one "treats" a friend to a drink; the friend wishes to return the compliment and so they drink again; the person with deficient self-control—and what little he has now lessened—insists upon a third, and so on, perhaps to intoxication. This, of course, does not always happen; thousands are strong and escape the danger, but thousands are weak or do not know better, and many a week's wages has gone in this way, leaving behind poverty and misery and impaired capacity before the close of Saturday night.

21. Concluding remarks on the use of alcoholic beverages. In the foregoing pages we have stated the salient facts concerning the physiological action of alcohol and alcoholic drinks. It only remains to point out for the student the obvious conclusions to be drawn from them and from the long and, on the whole, very sad experience of the race with alcoholic drinks. The first is that except in sickness and under the advice of a physician, alcoholic drinks are wholly unnecessary and much more likely to prove harmful than beneficial. The second is that their frequent and especially their constant use is attended with the gravest danger to the user, no matter how strong or self-controlled he may be.

It is true that history and romance and poetry contain many attractive allusions to wine and other alcoholic drinks, and it may also be true that such drinks, by loosening tongues and breaking down social, political, or other barriers (removing inhibitions), may tend towards conviviality and good-fellowship; but it is no less true that the path of history is strewn with human wreckage directly due to alcohol; that many a promising career has been drowned in wine; and that indescribable misery follows in the trail of drunkenness. The only absolutely safe attitude toward alcoholic drinks is that of total abstinence from their use as beverages.

22. Opium, morphine, and the opium habit. The danger of the use of drugs as a regular habit of life is perhaps most painfully illustrated by what is known as the opium habit. Among the most valuable remedies at the physician's disposal is opium or its active principle, morphine, which possesses remarkable power to produce insensibility to pain. It sometimes happens, however, that by incautiously using this drug for this purpose men and women become addicted to the habit. They finally cannot do without the drug, and its constant use causes an appalling moral and physical degeneration; so far indeed does this often go that the victim will commit crime in order to obtain the drug. It should be clearly understood that it is unsafe for anyone to use opiates to relieve pain; indeed, these should *never* be used except when prescribed by a careful physician.

23. Chloral, cocaine, etc. Men and women may become slaves to the use of other drugs and in much the same way as they become slaves to alcohol and morphine. Among these drugs are chloral and cocaine. They belong in the same general group of hypnotics or anesthetics, and the habit acquired is perhaps no worse than the opium habit. It is certainly very little better. Let the student remember that the root of the evil here, as elsewhere, is the substitution of the use of the drug for normal habits of healthful living.

24. Tobacco. The physiological effects of tobacco are quite complicated, so complicated that it is difficult to make general statements with regard to them. The effects of chewing are quite different from those of smoking, and those of smoking, no doubt, vary according as the smoke is or is not drawn into the lungs (inhaled).

The leaf of tobacco contains a poison (*nicotine*) which exerts a powerful action on the heart and on nerve cells. It is not, however, proved that the bad effects of the use of tobacco are due entirely or even chiefly to this substance, but it unquestionably contributes to the physiological effects.

The smoke from tobacco also contains ammonia vapor which locally irritates the mucous membrane of the mouth, throat, nose, etc., and this irritating action at times acts as a stimulant to the whole system in much the same manner as do "smelling salts."

It has been recently suggested that, owing to the incomplete character of the combustion, tobacco smoke contains a small amount of the poisonous gas carbon monoxide (CO), and it is quite possible that some effects of smoking — especially where the smoke is drawn into the lungs (inhaled) — may be attributed to this gas; but the suggestion has not yet been submitted to the test of actual experiment.

Indeed, the physiological action of tobacco probably not only varies with the form in which the tobacco is used but is in any case the result of a combination of a number of factors partly physiological and partly psychical. We must here, however, confine our attention to the purely hygienic aspects of the matter.

Human experience shows that the unwise use of tobacco may unfavorably affect digestion, cause serious disorders of the heart, and impair the work of the nervous system. Those training for athletic events are usually forbidden the use of tobacco because it "takes the wind"; that is, makes impossible the most efficient training of the heart. Many employers have found that youths who smoke cigarettes are less reliable in their work; and this is only one instance of the effect upon the nervous system already referred to, the same result being observed in a diminished steadiness of the hand, often amounting to actual tremor.

These effects do not, of course, manifest themselves in their extreme form whenever tobacco is used, but it is probable that they are always present in some degree. Whether they are noticeable or not depends largely upon the ability of the constitution to resist them. Tobacco is thus often used without demonstrable bad effects when one is leading a hygienic life; but very often the habit, formed under these conditions, persists after the increasing intensity of occupation and the attendant cares and responsibilities of life result in neglect of muscular exercise and improperly directed nervous activity. As this neglect begins to tell on general health it is found that the unfavorable effects of tobacco become more pronounced.

Especially to be condemned is its use by those who have not attained their full growth. During youth nothing should be allowed to interfere with the best development of the heart and nervous system, and the use of tobacco endangers the proper development of both of these most important parts of the human mechanism. It can hardly be doubted that many a young man has failed to make the most out of life because the habit contracted in youth has struck in this way at the foundations upon which he had subsequently to build.

CHAPTER XXI

THE PREVENTION AND CARE OF COLDS AND SOME OTHER INFLAMMATIONS

1. Hygiene and physical efficiency. A most important aim of personal hygiene is the maintenance of the highest working efficiency of the body. We should not be content with the avoidance of serious maladies like smallpox, diphtheria, and consumption, but should try also to avoid those minor ills which, though temporary and rarely fatal, may seriously interfere with our capacity for usefulness and enjoyment. The importance of avoiding constipation has already been pointed out (p. 132). The present chapter will be devoted to the practical consideration of such common complaints as *colds*, *rheumatism*, and *diarrhea*, all of which are accompanied by inflammatory conditions in some internal organ or organs and are favored by exposure to cold, drafts, or dampness, which chill the skin and drive the blood into the internal organs.

2. Some common complaints and the conditions which favor them. We shall not give any extended account of the nature of the complaints mentioned in the preceding paragraph, for their exact causes are still obscure. Two points, however, should be emphasized for all of them.

1. *The exposure to cold is not usually the cause of these diseases, but only favors their development.* It is the general experience of arctic travelers that they suffer very little or not at all from "colds." Nansen and his men were away in the *Fram* for more than three years. During a large part of that time Nansen and Johannson journeyed on sleds

or afoot, exposed to the worst rigors of an arctic climate; at times, after getting into their sleeping bags, they had to thaw out their frozen clothing by the heat of their own bodies before they could go to sleep. Yet not one of them had "a cold" until their return to Norway, when an epidemic of colds broke out among them. This and numerous similar experiences of others suggest strongly that colds are largely infectious diseases, but we must not forget that dampness and drafts are favoring conditions for their development. The experience of the race on this point is abundant and conclusive.

2. *Each of these diseases is characterized by a condition of inflammation.* We shall not attempt to describe the exact nature of inflammation; it is sufficient to recall features of it familiar to everyone. The sting of a bee or hornet or the bite of a mosquito results in local inflammation of the skin; a severe case of sunburn presents a similar condition over larger areas; a wound of any kind often shows more or less of the same inflammatory process. The part becomes *red*, indicating the presence of an increased amount of blood; it is *swollen*, partly because of the greater quantity of blood and partly because of the greater quantity of lymph present in the tissue; it is usually *hot*; and it is often *painful*. At times, as in the case of a wound or boil, *pus*, or "matter," may be formed.

One or more of these conditions is present in an inflamed organ during the diseases mentioned. When we have a cold in the head (*rhinitis*) the vascular membrane lining the nasal cavity is the seat of trouble; in a sore throat it is the pharynx and larynx (*pharyngitis* and *laryngitis*); in a cold on the chest (*bronchitis*) it is the ciliated membrane of the trachea and bronchi; similarly in catarrhal attacks of the stomach and intestine it is the mucous membrane of these organs; and we must think of these inflamed tissues of the respiratory and alimentary tracts as presenting somewhat the same condition as that seen in the skin during a bad case of sunburn. They all have an excessive amount of blood within them; they are more or less swollen — as when one's "nose is stopped up"; there is an unusual amount of fluid in the tissue; and there is, besides, generally a *transudation* of this fluid to the surface, as in the "running of the nose."

3. Congestion during inflammation. The presence of an excessive quantity of blood in the capillaries of an organ is known as "congestion"; and this may be of two kinds — *active* (or *arterial*), due to an excessive supply from the arterial reservoir; or *passive* (or *venous*), due to some interference with the outflow into the veins.[1]

In a cold, congestion of the inflamed area begins as an active congestion; the arteries are widened, the pressure in the capillaries is increased, and the blood flows much more rapidly. This is essentially the same thing — only in greater degree — that occurs when the arterioles of the stomach dilate during digestion or those of the skin during exposure to warmth. This initial vascular stage is succeeded by one of passive congestion, caused by the adhesion of white blood corpuscles to the capillary walls, thereby diminishing the bore of the tube and so making difficult the outflow into the veins; the velocity of the blood through the capillaries is lessened, pressure within them is increased (why?), and they become gorged with blood. Such is the vascular condition in an organ when an inflammatory process is at its height; *the characteristic feature is the narrowing of the outlet of the capillaries and the consequent excess of pressure within them.*

4. Dangers connected with congestion. A decidedly congested condition is undesirable because it is a predisposing

[1] The artificial model described on page 144 may easily be used to show the difference between arterial and venous congestion. With the nozzle in the far end of the rubber tube, the tube may be congested (or swollen) with water by more rapid pumping (active congestion) or by narrowing the outlet (passive congestion).

cause of these inflammatory diseases. It is not the only cause nor the exciting cause of the disease; but a congested organ may succumb to an attack of disease and so become readily inflamed where it would have escaped had its vascular condition been normal. For example, the normal intestine may be the seat of some unusual bacterial action (see Chap. VIII, p. 130) and suffer no damage therefrom, while the same bacterial action may give rise to catarrhal inflammation, accompanied by diarrhea, if it occurs when the intestinal blood vessels are congested. Or again, whatever the cause of an ordinary cold may be, bacterial or otherwise, it is probable that its attack upon the perfectly normal organism may be and frequently is resisted; while at another time a congested condition of the nose, the throat, or the bronchial tubes may permit the disease to gain a foothold at that point. In other words, the congestion alone will not *cause* colds in the head or on the chest or diarrheal troubles in the intestine; something else is needed. We may have the congestion without the cold, and we may also succumb to a cold without the preliminary congestion; but the presence of congestion often presents to an infecting agent the weak spot which is needed in order that the latter shall secure a foothold and do damage.

5. The avoidance of congestion during colds, etc.; the care of catarrhal conditions. Again, whenever an inflammatory process is established, there is, as we have seen, more or less of passive congestion; under these circumstances everything should be done to *avoid arterial dilation in the inflamed area.* Suppose there is catarrhal inflammation of some part of the small intestine, accompanied by diarrhea; the outlet into the veins is narrowed, and there is consequently more or less "backing up" of the blood in the capillaries (passive congestion). This congestion is kept within moderate limits so long as the arterioles maintain a good tonic constriction and so limit the amount of blood which can flow in; if, however, they are made to dilate widely by eating a hearty meal, for example, this check is removed, blood flows in under high pressure, and the congestion is increased. Hence in all such catarrhal attacks the diet should be very light and preferably confined to those things which are easily digested and absorbed.

6. The care of colds, etc. Again, when suffering from any of these inflammatory diseases of internal organs the greatest

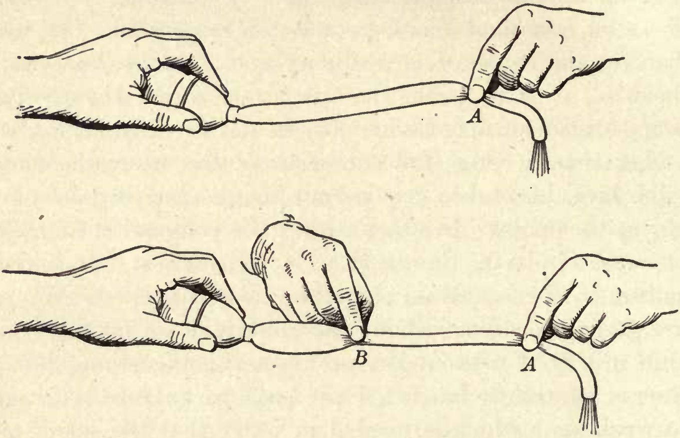


FIG. 118. Experiment to show the effect of arterial constriction in relieving capillary congestion

In the upper figure constriction of the tube at *A* results in distention (congestion) of the tube between the pump and the fingers; if, however, the tube be also constricted at *B*, as in the lower figure, pressure falls between *A* and *B*, and the congestion is relieved

care should be taken to avoid chilling the skin, because this means (Chap. XII) compensating dilation in the inflamed area and therefore increase of congestion there. One should be warmly clad (not overclad); the living and sleeping rooms, though well ventilated, should not be cold; when a cold sleeping room cannot be avoided some covering for the head is often useful, as this part of the body is not protected by the bed covering; cold baths should be discontinued; and, above all, dampness should be avoided. In severe cases it is often necessary for the patient to go away from a damp climate to a dry one. The *key to the situation*, so far as the management of the circulation is concerned, *consists in keeping in the skin its full share of blood.* A brief chilling of even a comparatively small area of the skin (for example, cold feet) may produce a congestion in the inflamed organ capable of undoing the healing work of hours or days.

A word must be said in this connection about the "fresh-air" cure for colds, etc. There is no doubt that being in the fresh, dry air, even if it is cold air, and preferably out of doors, is better for a cold or any other catarrhal condition than remaining in a closed room. But this should never involve the chilling of any portion of the skin; one should be warmly clad, even the head and neck being well protected. It makes little or no difference that we *breathe* cold air, but it makes a very great difference whether or not the *skin* is exposed to cold air.

In taking care of colds and similar troubles it is well to remember that the inflammation is only one of the unfavorable conditions against which the system is struggling. Consequently we should not expect the disease to yield in all cases to our measures for keeping the skin warm. At times a hot bath, a drink of hot lemonade, or other measures for bringing the blood to the skin checks a threatened cold, but none of these measures is of great value after the disease has once obtained a foothold. It is then a struggle between the body and the disease; and we can do more by merely avoiding the chilling of the skin than by taking measures to produce marked cutaneous dilation. The true policy, in other words, is to give the living body every chance to cure itself, and this is best done by not calling on it to do too many other things at the same time. Thus muscular exercise, ordinarily one of our best means of keeping the blood in the skin, is not usually advisable when a cold is at its height, because an added strain would thereby be imposed on the already sorely taxed system. Later, when the worst is over, it is a valuable aid, though it should not be too vigorous until one is on the road to complete recovery.

"Stuff a cold and starve a fever" is one of those pithy sayings whose very pith may be poisonous. A full meal when we have a cold in the head often clears up the nasal congestion for a time (probably by drawing the blood to the stomach and intestine) and so deludes us into supposing that our "stuffing" has done good. It may also, and doubtless often does, support and reënforce the body in its battle with the disease. What it may do, however, is to overtax the body with the digestion of a heavy meal; the meal may not be properly digested; bacterial processes in the excessive mass of food may produce abnormal and poisonous substances (see Chap. VIII) which gain admission to the blood, and the "last state" of the patient may be "worse than the first."

7. Measures for stopping colds. When one "feels a cold coming on," that is, early in the struggle, active measures should first be taken to dilate the blood vessels of the skin. A hot bath before going to bed and hot drinks, such as hot lemonade, may be tried. If the cold does not promptly yield to these measures, rest in bed is usually the best treatment. The nervous system is frequently in no condition to sustain hard work of any kind, and hence, until the cold begins to clear up, it is well to confine the diet to easily digestible foods in moderate quantity and to remain very quiet. Few people, unfortunately, act on this principle. "It 's only a cold" is made the excuse for meeting every engagement that may have been made or for attempting to do full work. Sometimes, perhaps generally, no serious results follow, but at other times the penalty is heavy.

Very often a cold is a more serious matter than we suppose. Only physicians appreciate how often it is the sign of more serious disease.[1] While we cannot say that one should always stop work until the cold is overcome, we do say that limiting work to the minimum and securing all the rest possible is always advisable and should be the rule rather than the exception. We may, unknown to ourselves, be nursing more than a cold, and, even if we are not, we always hasten the cure by taking care of ourselves.

8. The use of drugs for catarrhal conditions. A remedy very frequently resorted to for colds and other inflammatory troubles is the taking of some drug. Large fortunes have been made by the sale of "cough medicines" and the like. Some of these "remedies" are worse than useless; others may do no harm, and some may be useful. *But none of them are cures.* The cure of the cold is effected not by the drug but by the system of the patient; the drug can do no more than remove some condition which stands in the way of the healing effort of the organism. The severe coughing of a bad case of bronchitis is often irritating to the inflamed surface of the air passages and may stand in the way of clearing up the inflammation. Here a drug may do good, though it should be taken only on the advice of a physician and never on the strength of newspaper testimonials to its alleged virtues. But the use of these medicines does not render unnecessary the measures we have outlined as the proper treatment. It is worse than foolish to dose one's self with drugs when a cold is coming on and then attempt to do full work; often the only result of such folly is a complete "knocking out of the stomach" by the drug. The average "cough medicine" is especially likely to do this.

9. The belief in drugs. A century ago the attitude of men and women toward practical hygiene consisted largely in living

[1] In typhoid fever a "cold on the chest" is frequently the first outward indication of the disease.

in ignorance of the workings of the body, taking little or no care of it, and then whenever bad feelings appeared "taking something simple" to cure them. This course of conduct was persisted in until something happened, — and something usually did happen, sooner rather than later, — when recourse was had at once to drugs. The doctor was the man who knew what drug to "give" for each disease. He was expected to "prescribe"; and if he did not prescribe something, he failed to satisfy his patient, who concluded that the physician did not understand the disease. The attitude of the public was largely that of neglecting personal, individual care of the health and meantime implicitly believing that no matter what happened some drug could be swallowed which would set matters right.

Medicine and, especially, personal hygiene have now advanced beyond this crude condition. To-day we realize as never before that the individual is responsible for the intelligent care of his health. The time is probably coming when he will be held as responsible for the care of his body as he is to-day for the care of his morals. At the same time drugs are being much less used by the best physicians. It is not true that all drugs are useless; quite the contrary; but it is true that careful nursing often counts for more than does the use of drugs. Typhoid fever is to-day often treated with no drugs at all, and the tendency to use drugs in other diseases is distinctly lessening.

The wise physician is often hampered in his work by the survival of this old-fashioned belief in the all-sufficiency of drugs. Instances of it are sometimes encountered even among otherwise intelligent people. We should understand that in all cases of illness the one treatment which should be applied is good nursing, whether by a trained nurse, or by one's family, or by one's self. If medicine is given, it is usually subsidiary to the main procedure, although sometimes, as in the antitoxin treatment of diphtheria, it is the main thing. But in no case should we be so foolish, so unreasonable, as to distrust or lose confidence in a physician because he gives few drugs or none at all.

10. The avoidance of colds, etc.; general principles. If the care of these slight ailments is of importance, their prevention is of much greater importance. And first of all among preventive measures must be placed not the avoidance of drafts and other chilling of the skin, not clothing, but *the proper hygienic care of the body*—regular and sufficient muscular exercise, the avoidance of improper feeding (for colds are often due to digestive disturbances resulting from overfeeding), and good habits of sleep and rest. When these things are properly attended to, one may usually suffer considerable chilling of the skin without ill effect. It is not true, as is often asserted, that by attention to these general matters the protection of the body from exposure to cold becomes unnecessary, but it is true that without this attention such protective measures are apt to be of little avail.

Among general measures none is more important than the *avoidance of exposure to chilling influences when the nervous system is depressed by marked fatigue.* We take cold more readily, just as we are more susceptible to any disease, when we are tired. It is a question of a struggle between the organism and unfavorable external or internal conditions, and, in general, the greater the fatigue of the organism the less is its chance of success in the struggle.

11. The avoidance of colds; special measures. As to measures specially concerned with the avoidance of congestion in internal organs, let us first state clearly the principle involved and then pass to its practical applications. The condition to avoid is the undue constriction of the blood vessels of the skin, produced by chilling. The danger is not in the mere exposure to cold; people may be comparatively lightly clad on a cold dry day, when there is no wind, without chilling the skin, because the layer of air in contact with the skin becomes warmed, and in the absence of wind even light clothing, if dry, suffices to keep this warm air in contact with the body. But if the air is damp, so that it readily *conducts* heat, or if the wind is blowing, so that *convection* becomes important, or if the body is near cold objects to which it can *radiate* its heat, the skin may be easily chilled, especially if we are making no muscular exertion.

Again, during muscular exertion exposure to cold is usually harmless, even if the clothing be light, because the increased heat production within the body results in an adequate flow of warm blood through the skin. We seldom take cold during vigorous muscular work on a cold day. It is when we are sitting still or, even more, when we are lying down and the muscles are liberating less heat that we should be on our guard.

Finally, and most important of all, is the fact that the "danger zone" of atmospheric temperature is confined to the narrow limits of a few degrees just below the proper room temperature. This proper room temperature is for light clothing about 66° F. with low or normal atmospheric humidity and about 69° or 70° F. for high humidity. Above these points there is no chilling of the skin. Five or ten degrees below these points we feel so cold that we become uncomfortable and take steps to remedy matters, either by putting on warmer clothing or by heating the room. It is when the temperature is only *slightly* below what it should be that we are apt to be unaware of the insidious increase of arterial constriction and chilling in the skin, until, after an hour or more of it, we suddenly awake to the true condition of affairs. This is apt to happen when the fire in the stove or in an open grate goes down. It also happens at times when we come from a walk out of doors into a room of this "dangerous temperature," say 63° F. on a day of high humidity; the skin is warmed by the exercise we have been taking, so that, as we enter the room, it does not seem cold (for the temperature we really notice is that of the skin, not that of the room at all); on sitting still in the room the cutaneous dilation of muscular exercise passes off so gradually that we do not notice the change, and, before we are aware that we are chilly, marked internal congestion may have been produced.

It is also well to remember that not all parts of the room have the same temperature. The floor is colder than the ceiling; it is colder nearer exposed walls and windows than away from them, and the common habit of sitting near a window on a cold day while reading or sewing is unwise.

12. Cooling off suddenly. It is an old saying that it is not well to "cool off suddenly." While there is some truth in this, it is not true in general, nor in the form stated. It is perfectly safe for most healthy people to take a cold bath after exercise or to pass directly from a hot bath into a cold one (see Chap. XXV). The sudden cooling which experience has found to be harmful is where the clothing has been saturated with perspiration and one cools off by sitting still in a breeze or in a cool place. Here *the clothing remains damp* and so conducts heat readily from the skin, and the danger lies not in the cooling off but in the prolonged chilling process which follows it. Consequently it is a general rule that clothing made damp by rain or perspiration should be changed as soon as possible or else that drafts and cold rooms should be avoided until the clothing is dry.

It is unnecessary to multiply examples. In all the principle is the same — the avoidance of conditions which produce marked constriction of cutaneous blood vessels, with the accompanying congestion of internal organs; and the student is again reminded that by this course we do not always secure immunity from internal inflammations, but merely remove one of the conditions which favor their development.

13. "Hardening" the system to cold. We must refer briefly to the importance of what is popularly known as hardening the system to cold. Cold unquestionably produces its effects in some people more readily than in others, and these differences are largely dependent upon habit or training. When the living rooms are kept above 70° and heavy clothing is always worn out of doors, the skin is constantly subjected to a tropical climate and becomes more sensitive to external cold. Internal congestion will then be produced at 67° or 68° F. which would not take place above 60° or 62° F. in persons who have been accustomed to cold. In other words, it is possible to overdo the matter of protection from external cold. For this reason overheated rooms and the use of heavy wraps while walking in moderately cold weather (30° to 50° F.) are very objectionable.

We should thus harden ourselves to cold; but it should never be forgotten that the process of hardening may be carried too far. To harden one's self does not mean that the temperature of the living room should be kept below 65° F. nor that sleeping rooms should be cold enough to freeze water at night. Severe colds and rheumatism have been contracted by this folly.

Many people fail to realize that because a little will do good, it does not necessarily follow that more will do better. One person is impressed by the undoubted fact that it is possible to eat too much meat, and thereupon abstains from meat altogether; another discovers that a sedentary life is a bad thing, and hastens intemperately to take "century rides" on a wheel. One finds that he has been overclad, and, discarding all warm clothing, shivers throughout the winter; another, on learning the possible value of cold bathing, enthusiastically but unwisely plunges into the coldest water he can get, and stays in it until his skin is blue. Very likely any one of these examples can be duplicated from the reader's own circle of acquaintances. It is important to remember that "nothing too much" is always a good rule, and nowhere is it more essential than in the hygienic conduct of life.

14. Reasons for avoiding colds and other inflammatory troubles. We may conclude this chapter with some facts showing the hygienic importance of the prevention of colds and other inflammatory diseases, such as sciatica, lumbago, and rheumatism in its various forms. In all these diseases we find the same close connection between the chilling of the skin and the onset of the disease, so that what has been especially urged with regard to colds applies in large measure to the entire group. But some may say, "These are slight ailments; why not ignore and disregard them?"

1. The first and sufficient answer is that these ailments interfere seriously with our working power and with our capacity for usefulness and enjoyment. Everyone knows from experience that the body is not so good a machine during the progress of a cold or a diarrheal attack or while suffering from sciatica or slight attacks of rheumatism. We should strive not only to live, but to live well; not merely to do things, but to do them with our might; not merely to live and work, but to live happily and to work cheerfully.

2. The popular impression as to the frequency with which pulmonary consumption, pneumonia, etc. are preceded by common colds is much exaggerated. It is nevertheless probable that in some cases a cold is the means of lowering the power of resistance to the more serious disease, and we should take every reasonable precaution which will maintain the ability of the body to cope successfully with the inroads of diseases, especially of those for which there is no certain cure.

3. Colds and similar troubles have a well-known tendency to become chronic. Probably no sufferer from nasal catarrh, or chronic bronchitis, or chronic diarrhea, if he had his life to live over again, would neglect measures tending to avoid the occurrence of these conditions. Only those who do not know from experience the capacity of such troubles to produce annoyance and discomfort can regard their prevention

as unworthy of serious attention. We cannot too strongly emphasize the fact that chronic troubles are very frequently the result of the repetitions of the neglected inflammations which accompany the acute attack; they are due not so much to inherent weakness of the tissue or organ as to the carelessness of the individual about avoiding them or the failure to give them the attention they deserve when they occur. One of our leading physicians, a man of the widest experience and soundest judgment, writes, concerning chronic nasal catarrh, "It is sad to think of the misery which has been entailed upon thousands of people, owing to the neglect of nasopharyngeal catarrh by parents and physicians."

CHAPTER XXII

THE CARE OF THE EYES AND EARS

The visual apparatus (eye, optic nerve, nerve endings, etc.) furnishes one of the most important paths from the world without to the brain within, and it is of the utmost importance to the exercise of the highest functions of the human mechanism that this path be kept as smooth as possible. Unfortunately, however, the path is seldom either straight or smooth, and it frequently presents serious obstacles. The curvature of the cornea or of the lens may be irregular; the muscle of accommodation may be weak; the retina may be too near or too far from the lens, or its sensitive cells may too readily become fatigued by the stimulation of light; finally, the path into the brain may be made of poorly constructed nervous tissue, or in the brain itself the coördinations upon which depend our visual judgments (p. 253) may be imperfect. The simplest act of vision is the end result of a most complicated series of events, difficulty with any one of which may make quick and accurate seeing impossible. Many a child has been considered stupid simply because an unrecognized condition of myopia or astigmatism renders it impossible to read clearly the printed page or the distant blackboard; and many people, adults as well as children, suffer from headaches and other troubles because of the strain thrown on the nervous system in the effort to work with defective vision.

When one is leading an outdoor life, occupied in the work of the farm or the lumber camp, and doing but little reading, the eyes usually give little trouble, because it is only when looking at near objects (three feet or less away) that the mechanism of accommodation is called into vigorous action. Eyestrain is usually produced by prolonged near work with eyes incapable of enduring without undue fatigue what is demanded of them. Hence it is that defects of vision are more common to-day than they were a hundred years ago. Both the vocations and the avocations of modern life, with their large amount of reading, writing, and other forms of near work, impose upon the eye the most trying and difficult task it can be called upon to perform. The use of glasses is more common than formerly, and the care of the eyes is forced upon us as an important factor in the hygienic conduct of life.

1. The necessity of expert advice. In the care of the eyes expert advice is indispensable. The detection of defects of vision frequently demands the best skill of those who are thoroughly acquainted with the physiology of the entire visual apparatus, including its relation to other bodily functions, and who are also provided with every means for gaining an insight into the conditions which are giving trouble. The selection of the proper glass, for example, when lenses are needed is more than a mere matter of testing vision with test cards; and eyes may be seriously injured by using glasses prescribed on the basis of information gained by imperfect methods.

First of all, then, let us insist upon the necessity of competent medical advice whenever there is reason to suspect something wrong with the eyes. If vision is not distinct, if the eyes tire quickly when used for near work, and *even when one suffers from headaches, "nervousness," and other forms of malaise without apparent cause*, it is wise to find out whether some remediable defect of vision is not at the root of the trouble.

On first thought it may seem unreasonable to consult an oculist with regard to headaches or other troubles with organs having no obvious connection with the eye; but when we remember the fact that all parts of the central nervous system are connected with one another, it is easy to see how undue strain of one part in the effort to see with astigmatic or otherwise defective eyes may, by injuriously affecting other parts of the brain or spinal cord, unfavorably influence organs which themselves have nothing to do with vision. Over and over again it happens that headaches and other troubles are relieved, as by magic, when vision is made perfect by the use of proper glasses.

With these remarks as to the importance of skilled advice in the care of the eyes, we may pass to those practical measures which should be under the intelligent individual control of every man and woman. Suppose vision is perfect, or as nearly perfect as the best of medical skill can make it, what precautions in the use of the eyes favor the maintenance of their best working condition?

2. Resting the eyes. First of all we would suggest the importance of resting the eyes now and then while engaged in near work. This is accomplished by the simple expedient of looking for a few moments at some distant object (p. 246). The brief relaxation of the effort of accommodation does for the neuromuscular mechanism involved exactly what a brief relaxation of the body in sleep accomplishes for the body as a whole.

3. Illumination of the object; the importance of contrast. The ease with which the details of an object are seen depends chiefly on the contrasts of shade and color which these details present to the eye, and nothing so influences this contrast as the amount of illumination. Thus as the light fades in the evening, the white paper of a printed page becomes darker and darker, until finally it reflects to the eye little more light than the black ink of the printed letters, which consequently no longer stand out clear and distinct. In order to admit all the light possible, the pupil enlarges and, in so doing, lessens the distinctness of the retinal image (spherical aberration); more important than this, we hold the page closer to the eye, thereby enlarging the retinal image and increasing the intensity of stimulation, but throwing far more work upon the ciliary muscle to focus for the near object. All of these unfavorable conditions taken together place undue strain upon the mechanism of accommodation.

Hardly less objectionable is excessive illumination of an object. After a certain intensity of light is reached, the retina no longer responds to increase of stimulation with increase of visual reaction. If there were in addition to our sun a second sun which sent into the eye twice as much light, the second sun would seem no brighter than the first because the effect of the first upon the eye has already passed the point which calls forth the greatest possible reaction in the retina. To apply this principle to the case in point we have only to remember that a printed letter is not absolutely "dead black," but reflects some light. When the illumination is moderate this reflected light hardly affects the retina at all, and the contrast between the black letter and the white paper is marked. As the intensity of illumination increases, however, the effect upon the retina of the light coming from the letters increases more rapidly than the effect of that coming from the paper. Contrast is lessened and sharper accommodation as well as closer attention is needed to see distinctly. Added to this, no doubt, is the fatigue and lack of sensitiveness in the retina, resulting from overstimulation.

4. The size of type. The use of fine type should be reduced to a minimum, because it necessitates greater effort of accommodation and intensifies all the evils of improper illumination. Any printed matter which must be held less than eighteen inches from the eye in order to be seen clearly is undesirable for long-continued reading. Especially is this true in youth, since then the eye is more plastic and excessive strain of the muscle of accommodation, pulling as it does on the sclerotic and the choroid coats, may lead to permanent deformation of the curved surfaces. The marked increase of myopia within the past forty or fifty years is perhaps to be explained in this way.

5. Highly calendered paper objectionable. Closely connected with the size of the type is the character of the paper on which it is printed. This should be as dull as possible in order to avoid the confusing effect of a glossy surface. The use of highly calendered paper in many books and serial publications, because such paper lends itself more readily to the reproduction of pictures in half tone, is a sacrifice of hygienic considerations to cheapness.

6. Importance of a steady light; reading on railroad trains. The source of illumination for near work should be as free as possible from unsteadiness or flicker, since a flickering light necessitates the most accurate accommodation. A "student's lamp," "Rochester burner," "mantle" gas flame, or incandescent electric lamp is preferable in this respect to candles, "fishtail" gas jets, and arc lights.

For the same reason caution is demanded in the matter of reading on railroad trains. American railway trains have recently become so heavy, and the roadbed, rails, etc. have been so much improved in various ways, that the danger of reading or writing while traveling by rail is much less than formerly. At the same time the danger still exists, and reading on many railway and trolley cars is still to be done with caution or, better still, avoided altogether.

7. Microscopes, telescopes, and other optical instruments require close and sometimes continuous use of one or both eyes and are popularly supposed to be "hard on the eyes." But this is not necessarily the case, except for beginners and investigators — for beginners, because they try to see clearly by focusing with the eye rather than with the use of the focusing apparatus of the instrument; for investigators, because the eyes are used for too long periods at a time. Optical instruments are easily focused and, if care be taken to provide good lighting, routine work with them need not be specially trying to the eyes.

8. The removal of cinders. Particles of dust, cinders, etc. are often washed away from the surface of the eyeball by the copious secretion of tears which they call forth. Sometimes, however, they must be removed directly from the eyeball or the inner surface of the eyelid. In the case of the lower lid this operation presents little difficulty, for the eyelashes of this lid are easily seized, the lid drawn forward away from the eyeball, and the surfaces of the eyelid and eyeball readily inspected. If any foreign body is there located, it may be removed by the corner of the handkerchief. Successful manipulation of the upper lid is more difficult, because a piece of cartilage immediately above the eyelashes interferes with turning back the lid. The gaze of the patient should be directed downward, a small pencil or other cylindrical object pressed against the *upper* portion of the lid, above the cartilage, the eyelashes seized, and the lid turned upwards and backwards over the pencil.

9. Recapitulation; the care of the eyes. To summarize, we may remind the student that the eyes, no less than other organs, should be kept sound and strong by attention to the general health and welfare of the body. Work, play, rest and sleep, muscular exercise, wise feeding, and regular removal of the wastes — these and all other general hygienic habits help to keep the eyes sound and strong; but besides these, posture in work, lighting, paper (not forgetting wall paper), printing, dust, cinders, smoke, acid fumes, traveling, sight-seeing, and many other conditions have their effect. Finally, it must not be forgotten that the eyes are too precious to be trifled with, and that if one has sore or weak eyes, or pain in the eyes, or cannot see clearly to read or to write, or cannot plainly distinguish things near or at a distance, then it is always best to consult an oculist or the family physician for advice. Remedies or doctors puffed in high-sounding advertisements should be carefully avoided.

10. The care of the ears. Besides good care of the general health, which common sense dictates and which we have repeatedly urged as the fundamental requirement in the hygiene of all organs, there is but little which the individual can do for the ears. Deafness, especially total deafness, is a defect or injury perhaps no less serious than blindness. Acute hearing is probably as valuable as acute vision, and a partial loss of hearing is a handicap often harder to overcome than are some defects of vision.

Keeping in mind the auditory apparatus and its connections (Chap. XIV), it is easy to see that the drum may be pierced or otherwise injured by slender objects thrust in from without; that catarrh of the throat may easily extend into the Eustachian tube, inflaming it or choking its lumen or outlet; and that any thickening of the drum must tend to make its vibrations slower and more difficult. In these possibilities we have some of the actual causes of deafness, and none of them is of a kind to be treated by the patient. Any recognition of incipient deafness in one's self should be regarded as cause for consulting a good physician. No attention should be paid to advertisements promising to relieve deafness, for these are usually traps calculated to catch the ignorant, unwary, or credulous. It is dangerous to explore the outer ears with hairpins or other pointed objects, as the drum may thus be broken or other harm done.

11. Noise, though delighted in by savages, who beat tom-toms, blow conch shells, or otherwise tickle the sense of hearing, and though in moderation often found stimulating and enjoyable by persons who have been living in solitude or isolation, is by adults among the most highly civilized peoples more and more regarded as a necessary evil or even as a nuisance. Children, on the other hand, often delight in noise, and horn blowing, firecrackers, and pistol firing on holidays like the Fourth of July appear to give as much pleasure to them as pain to their elders. Adults also on occasions of rejoicing still ring bells, beat drums, blow horns, and fire cannon in order to express their emotions. Loud noise, like strong light, is unquestionably stimulating and exciting, and for these reasons, though justifiable at times of rejoicing, is something to be ordinarily avoided as far as possible in city life, itself already much too stimulating and exciting. One can, indeed, often learn to sleep even in the presence of distracting noises such as those of a busy city street, but such sleep cannot possibly be as wholesome as that enjoyed in quiet places. The constant whistling of locomotives, which was formerly a great nuisance in many American cities and towns, has been largely done away with, and the tendency of the times is to cultivate quiet not only as a private luxury but also as a public necessity.

CHAPTER XXIII

HYGIENE OF MOUTH, NOSE, AND THROAT. FOCAL INFECTIONS

The mouth and nose are the two great "portals of entry" of matter into the body. Through these portals, with the food and drink and inspired air, enter also countless foreign organisms or microbes capable of finding lodgment in and doing harm to the tissues. Against these organisms, however, the body has many means of defense. The lining of the air passages is moistened by the secretion of the glands of their mucous membrane, and the mucus which these glands secrete is kept moving toward the mouth or nostrils by the lashing of minute hairlike extensions (cilia) of the cytoplasm of the living cells (see Fig. 119). In this tenacious fluid most of these organisms as well as particles of dust, etc. are caught and carried back to the exterior. Where the mouth and nasal cavities pass into the throat are organs — the tonsils — from which leucocytes creep by amœboid movement (p. 137 and Fig. 66) into the mouth and

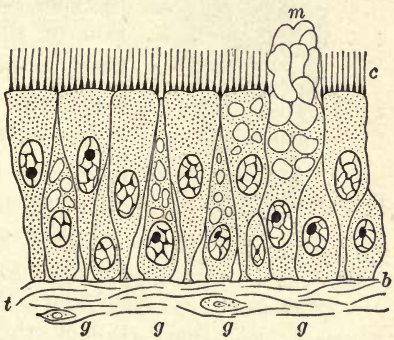


FIG. 119. Ciliated epithelium from the respiratory tract

Each cell rests on the basement membrane, *b*, and some of the cells extend to the surface; *c*, cilia; *t*, connective tissue; *g*, *g*, *g*, *g*, cells in the cytoplasm of which mucin is being manufactured; one of these cells is seen discharging its mucin, *m*, upon the free surface of the air passage throat where they devour many bacteria. Still another barrier is the acid of the gastric juice, which kills a large percentage of the bacteria swallowed with the food.

These defenses, however, although highly effective, are not perfect, and it often happens that microbes gain a foothold in places where they are partially protected in one way or another from defensive agents. Under these conditions they are not completely killed off; at best they are only retarded in activity and growth. Nowhere does this happen more frequently than in the mouth and nasal cavities themselves, and few advances of recent years in the field of hygiene are greater than the recognition of the importance of these infections in the preservation of health. We shall begin our discussion of them with a description of the structure of the teeth and practical suggestions regarding their proper care.

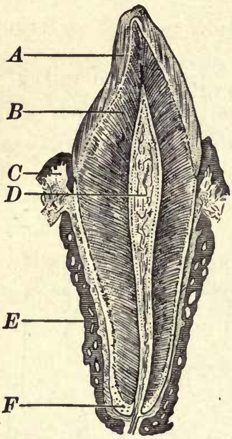


FIG. 120. Section of an incisor tooth. After Spalteholz

A, enamel; *B*, dentine; *C*, gum; *D*, pulp; *E*, jawbone; *F*, cement

1. Structure of a tooth. A tooth has three parts — the *crown*, or exposed portion; the *neck*, a narrow constriction at the edge of the gum; and the *root*, or roots, by which the tooth is fixed in the jawbone (see Fig. 158).

The tooth consists of a hard body surrounding a central *pulp cavity*, filled with a loose connective tissue containing blood vessels and nerves, which enter the pulp cavity by a minute opening on the tip of each root. Elsewhere the pulp is surrounded by the hard parts of the organ, which consist of three different tissues. Immediately surrounding the pulp, both in the root and in the crown, is the *dentine*, which makes up the main bulk of the tooth; this is a hard structure, containing some 65 per cent of mineral matter. It is channeled, as shown in the figure, by minute canals, the *dentinal tubules*, which run into the pulp cavity. In the root the dentine is covered with *cement*, which is virtually bone in structure and composition. This bony covering of the root is connected with the jawbone, in which it is embedded, by a layer of fibrous connective tissue which is torn when the tooth is pulled. In the crown, or that part of the tooth not covered by the gum, the dentine is covered with *enamel*, the hardest substance in the body. This contains in the adult from 95 to 97 per cent of very insoluble mineral matter and is the protective covering of the tooth. In structure enamel consists of columns, hexagonal in section, set together so as to form an impenetrable mosaic covering. It is thus admirably fitted to protect the dentine and, indeed, the whole tooth from mechanical injury, from chemical erosion, and from bacterial action. In the region, however, where crown and root join (that is, where enamel ends and cement begins) these covering structures are thin and at times imperfect. Normally this part of the tooth is protected from access of microbes and other matter by the tightly adherent gum, but sometimes this protection is insufficient so that foreign matter (including microbes) can get between gum and tooth. Consequently this forms, perhaps, the most frequent point of attack upon the integrity of the tooth.

2. Care of the teeth. Too much stress can hardly be laid on the preservation of the teeth. Apart from considerations touching personal appearance, the teeth are of great importance in masticating the food. Mastication, or chewing, is one of the many acts of digestion, and when the power of chewing is impaired, the efficiency of the whole digestive process is to that extent lessened; other portions of the alimentary tract, especially the stomach, must then do, as far as possible, what should have been done by the teeth; digestion is hindered; some kinds of food are never properly digested; and the opportunity for bacterial decomposition of the food is greatly increased because of the prolonged exposure of the food to bacterial action. Besides, there is always the possibility that a decaying tooth will cause the formation of an abscess (an ulcerated tooth), often a most painful and sometimes a dangerous thing.

3. Decay of the teeth is usually due to the action of bacteria, which grow upon food particles in the mouth and, in so doing, dissolve away the lime salts of the enamel and the dentine; the enamel, however, is acted upon very slowly and with great difficulty; so long as it is intact the underlying dentine, which is dissolved much more readily, is protected; but if for any reason the enamel becomes worn away, its absence should be made good by filling the tooth, thereby preventing access of foreign substances and, especially, of destructive bacteria to the dentine.

The action of bacteria upon the enamel is favored by the formation of a hard deposit known as *tartar*, a mixture of lime salts precipitated from the saliva and especially apt to be deposited between the lower teeth and in the neighborhood of the gums. Sometimes tartar is even deposited under the gums, in which case it is inaccessible to the action of a brush. Because of this tartar crust, bacteria and their harmful products are not properly rubbed away by the movements of tongue and cheeks, and hence the importance of its artificial removal. This is greatly facilitated by using a tooth powder or paste which contains some substance, like precipitated chalk, not hard enough to injure the enamel but exerting friction enough to break up the deposit. At least once or twice a week a good tooth powder or paste should be used in cleaning the teeth. At other times the brush and water are sufficient. After using powder, indeed always after brushing the teeth, the mouth cavity should be very thoroughly rinsed out.

It is, however, very difficult and at times impossible to remove the tartar entirely by the use of powder and brush.

For this reason the teeth should be examined by a dentist at least once a year, the accumulated tartar thoroughly removed, and the teeth polished. In this way the beginnings of decay are detected and measures can be taken to prevent its further progress. Further advice as to the care of the teeth can and should be obtained from a good dentist.

Decay of the teeth caused by bacteria is also prevented by removing as far as possible the food supply of these organisms, to whose growth and activity nothing is more favorable than particles of food between the teeth or otherwise in contact with them. The ideal plan is to brush the teeth with water and rinse out the mouth after each meal; in most cases this is perhaps more than is required; it may be suggested, however, that the teeth should be brushed at night as well as in the morning, and that brushing them at night accomplishes more toward restraining bacterial action than does brushing them in the morning.

Finally, keeping the teeth in sound condition is dependent on the maintenance of general health. The special measures we have outlined are useful and, indeed, necessary, but alone they do not guarantee success. The teeth, like other organs, require the good offices of the blood, the nervous system, etc., and everything which keeps the body in condition to do its work properly favors the sound condition of the teeth.

4. Riggs's disease; amœbic abscesses around the roots of the teeth. In addition to the above troubles, primarily involving decay of the enamel or dentine, another disease of the teeth is of great hygienic importance. This is the so-called Riggs's disease (*pyorrhea alveolaris*), which consists in the formation of an abscess (or pus cavity) between the root of the tooth and the jawbone. These abscesses are essentially regions of active microbic growth, with more or less destruction of the tissues concerned. In the fight with the invading bacteria white blood corpuscles (leucocytes) enter in large numbers, so that the cavity of the abscess comes to be filled with a mass of thick liquid (pus) consisting of disintegrated tissue, the infecting microbes, and large numbers of leucocytes, which in this case are known as *pus corpuscles.* It has been shown that the microbe concerned in forming many, if not most, of these abscesses is a one-celled animal, known as *amœba*, which, though larger, presents many points of similarity to the white blood corpuscle. With the extension of the abscess around the root, the tooth becomes loose in its socket and may finally drop out. Recently it has been found that the drug emetine, a constituent of ipecac, often kills these amœbæ and so stops the progress of the abscess.

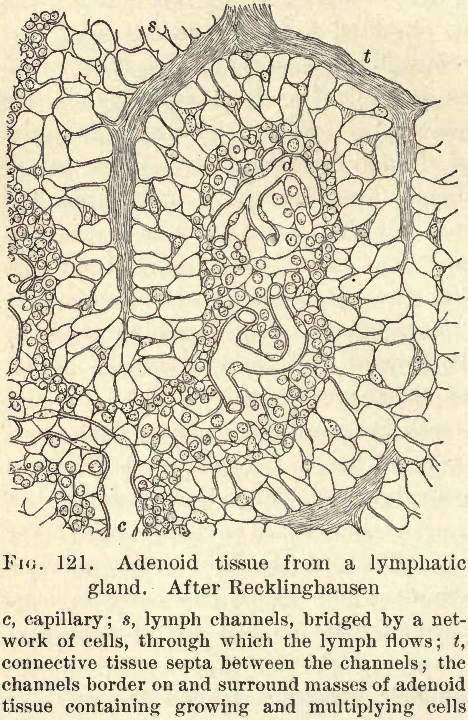


Fig. 121. Adenoid tissue from a lymphatic gland. After Recklinghausen

c, capillary; *s*, lymph channels, bridged by a network of cells, through which the lymph flows; *t*, connective tissue septa between the channels; the channels border on and surround masses of adenoid tissue containing growing and multiplying cells which pass into the lymph stream as leucocytes. In the lymph stream they are carried along the lymphatics into the blood vessels

Other abscesses around the root of the tooth are doubtless caused by certain bacteria. Absorption of the output of these various abscesses is believed to be depressing and sometimes dangerous.

5. The tonsils; adenoids. At the entrance of the mouth cavity into the throat or pharynx and in the pharynx itself are masses of *adenoid tissue*.[1] This consists of a network, the meshes of which are crowded with cells which by continued growth and multiplication form one kind of leucocyte. The two largest of these masses (one on each side), the *tonsils of the palate*, or in popular language "the tonsils," are readily seen on looking into the wide, open mouth. Another mass of the same tissue, the *lingual tonsil*, is a collection of lymph nodes at the base of the tongue in the median line; while a third, the *pharyngeal tonsils*, extend over more than an inch of the dorsal (or posterior) wall of the upper, or respiratory, portion of the pharynx; that is, above the level of the soft palate (see Fig. 14). Into each of these tonsils one or more blind tubes, or *crypts*, extend from the cavity of the pharynx. These crypts are lined with the same epidermal tissue as that which lines the general cavity of the pharynx, except that in their deeper recesses it contains fewer layers of cells. Through this epidermis the white corpuscles push their way by pseudopodia into the mouth, where they are known as salivary corpuscles. These are readily seen when a drop of saliva is examined under the microscope.

There is every reason to believe that this tonsillar lymphoid tissue placed at the entrance to the alimentary canal and the trachea performs the function of supplying large numbers of leucocytes to attack and kill invading bacteria. Unfortunately the tonsils are themselves liable to become infected, especially in their crypts, in which case we have enlarged and inflamed tonsils and also tonsillar abscesses, and the removal of the tonsils for such troubles is a very common operation.

[1] Many other masses of this tissue occur widely distributed in the body, chiefly as the enlargements on the course of the lymphatics, where they are known as *lymph nodes*, or *lymphatic glands*. The lymph current through the meshes of the lymph node carries leucocytes away with it and thus helps to keep up the normal number of white corpuscles in the blood. Other masses of the same tissue occur in the mucous membrane of the intestine, some of them of considerable size and readily seen with the naked eye. These are known as *Peyer's patches*.

The pharyngeal tonsils sometimes enlarge, especially in childhood, and form protruding masses, known as *adenoids*, within the nasal portion of the pharynx. These can obstruct the passage of air from the nasal cavity into the pharynx and so force mouth breathing, with its attendant ills, upon the victim of the trouble. Relief is obtained by removal of the adenoids.

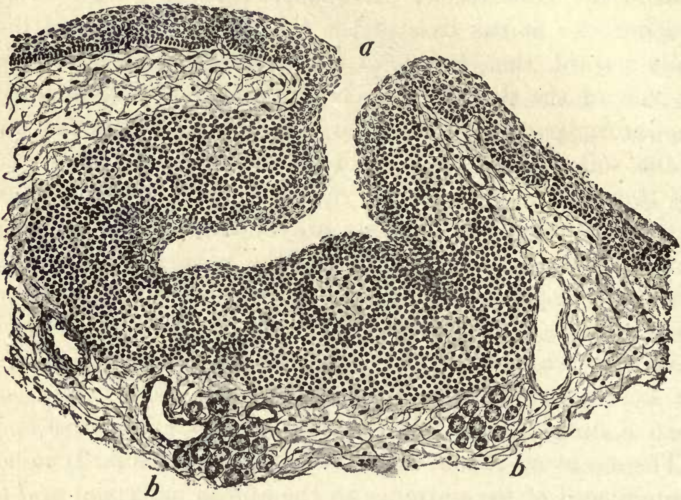


FIG. 122. The lingual tonsil of man. From Ferguson's "Histology and Microscopical Anatomy"

a, crypt of tonsil; *b*, glands in connective tissue. The epithelium of the mouth extends into the crypt, and under this epithelium are the masses of adenoid tissue, whose corpuscles bore their way through the epithelium into the crypt, from which they enter the pharynx

6. Focal infections. Any of the above infections or abscesses in teeth or tonsils obviously becomes the seat of a steady growth and multiplication of bacteria. Either these bacteria themselves or their harmful products (toxins) may be carried by the blood or lymph streams to other organs and there cause serious diseases, among which may be mentioned joint disease (*arthritis*, one form of what is popularly called rheumatism), inflammatory changes in the lining membrane of the heart, and possibly also gastric ulcer. Recent work indicates that other diseased conditions similarly have their origin in infected teeth or tonsils. Such infections are known as *focal infections*, since they consist essentially in some localized seat (or focus) of microbic growth and multiplication. The focus may be elsewhere than in the organs of the mouth or pharynx; tuberculosis, for example, is believed in many or perhaps in most cases to start from such unrecognized focal infections in lymph glands of the intestine or in other organs; these infections are acquired in childhood, where they remain latent until later life, when the pulmonary consumption develops as a "secondary" infection from this primary focus. In their detection and treatment skilled medical advice is necessary; for the present we have only to call attention to the importance of the mouth, nose, and pharynx as situations in which they are especially liable to occur, but in which they are fortunately accessible to treatment. Doubtless the ear, nose, and throat specialist will in the future be consulted as regularly as the dentist to detect the beginnings of trouble and so to conserve health.

7. Hygiene of the nasal cavities. The two nasal cavities into which the nostrils open are separated from each other by a median partition, or *septum*, supported by cartilage and bone. The walls of the septum are smooth, that is, not thrown into folds. The outer side of each nasal cavity, on the other hand, consists of very complicated folds of highly vascular mucous membrane, kept warm by the relatively large quantity of blood flowing through it and moist from the secretion of the mucous fluid upon its surface. These folds nearly fill the nasal cavity, leaving only narrow passages for the air from the nostrils to the pharynx. Ciliated cells sweep outward toward the nostrils the fluid moistening the surface. The entire structure serves the threefold purpose of warming the inspired air, of saturating this air with moisture so that it will not dry the throat and bronchial tubes, and of arresting the passage inwards of particles of dust, microbes, etc. For these purposes the nasal mucous membrane is much more effective than that of the mouth, because of the greater surface exposed to the incoming air. Hence the hygienic value of breathing through the nose rather than through the mouth. In children mouth breathing is also harmful to the developing teeth and gums and results in a malformation of the jawbones which interferes with proper enunciation. It is easy to see why adenoids should produce the same deformity.

Small openings from the nasal cavities lead into large cavities, or *sinuses*, within the bones of the skull.[1] These sinuses are lined by the same sort of mucous membrane with ciliated cells as that of the nasal cavity itself. They are of importance hygienically in that inflammatory infections of the nasal mucous membrane ("colds in the head") may extend into them, causing the so-called sinus infections. These are sometimes very serious troubles, at times requiring surgical treatment.

Finally, in view of the occurrence of infections in the nasal cavities and their communicating sinuses, and also in view of the fact that the mucous fluid moistening these cavities often contains infectious microbes removed from the inspired air, it becomes a matter of hygienic duty not to sneeze without placing a handkerchief in front of the nostrils. This simple precaution prevents the discharge of infectious material into the surrounding atmosphere and hence lessens the chance of infecting others. When one has a cold in the head and, especially, when one has tuberculosis of the lungs, it is hygienically a misdemeanor to sneeze or cough in a room without taking this precaution against infecting others; and the habit of using the handkerchief when coughing or sneezing is one that everybody should acquire.

[1] One of the largest of these sinuses is shown in the upper jawbone, above the roots of the teeth, in Fig. 158.

CHAPTER XXIV

THE HYGIENE OF THE FEET

The hygienic care of the feet consists essentially in maintaining the ability of those organs to bear easily and without discomfort the weight of the body. "Weak feet" are to blame for many unhealthful conditions; the discomfort or pain which they cause as one goes about the ordinary occupations of life subjects their possessor to nervous strain and often prevents the enjoyment of that muscular activity which the maintenance of health requires. Nor is it generally

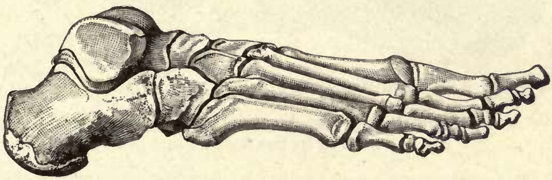


FIG. 123. Bones of the right foot

Seen from the outer side

known that this state of affairs may be very largely avoided by intelligent care. In the majority of cases weakness of foot is the result of maltreatment of the foot and not the result of inborn structural defects.

Each foot consists of no less than twenty-six small bones joined by ligaments and held in proper position relative to one another by the action of a number of muscles. The key to the understanding of the hygiene of the foot is the fact that it is upon the proper performance of the work of these muscles that the strength of the foot primarily depends and that the weakening of the foot is due to interference with their action, chiefly by the use of wrongly shaped shoes.

1. The arches of the foot. The bones of the foot should form two well-marked arches. One of these is the conspicuous arch of the instep and the other a less conspicuous but important transverse arch immediately back of the toes. Not only is the preservation of these arches important because they help to relieve the joints above them of jar but also because under them lie nerves, blood vessels, lymphatics,

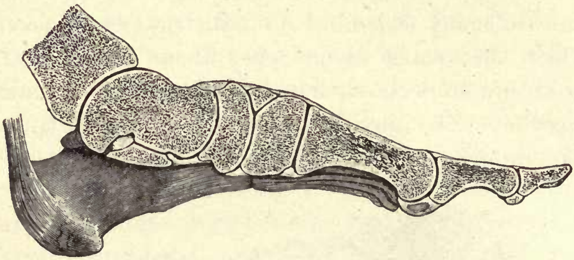


FIG. 124. Longitudinal section through the bones of the foot

Showing the arch of the instep and the attachment of the tendon of the calf muscle to the heel bone

and other tissues, which are injured when the arch gives way and permits pressure upon them from above. Fig. 164 shows the action of one of the groups of muscles which maintain the arch of the instep and illustrates, in principle, how muscular action keeps the bones in proper relative positions. The muscles shown in the figure (the short flexors of the toes) *act like the string of a bow* and, by contracting, resist the tendency of the weight of the body to break the arch down. Other groups of muscles are concerned, but it is unnecessary that we go into the details of their action. Enough has been said to show the importance of keeping these muscles strong, so that they may do the work imposed upon them.

The groups of muscles specially concerned are those which move the toes, and these, like other muscles, can be kept strong only by use. Consequently interference with the freedom of action of the toes must lead to the disuse and partial degeneration (weakening) of the muscles in question. *The fundamental principle in the care of the foot is none other than the maintenance of the freedom of motion of the toes, together with the use of the toes as well as the ankle in locomotion.*

2. The foot of the infant and the adult foot. Every human being begins life with a foot possessing wide range of movement, amounting almost to a grasping power. It is

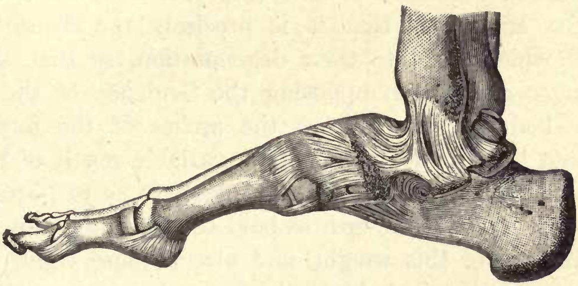


FIG. 125. Ligaments of the foot and ankle

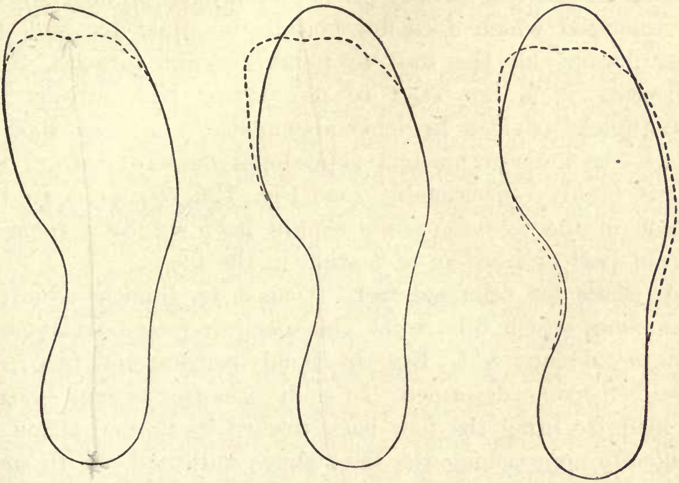
most instructive to watch a baby use its toes; not only are they bent downward or upward (plantar and dorsal flexion) and spread apart (abducted) with the greatest ease, but in walking the toes fairly grasp, or dig into, the ground. The adult foot of civilized man usually presents a painful contrast to this. Generally the toes are crammed together, their power of spreading apart is wholly lost, and their movements take no part whatever in walking. The foot, in other words, is reduced almost to the condition of a shoemaker's last.

Nor is this a natural change due to growth and development. It is produced by the use of shoes which *permit no adequate movement of the toes and therefore lead to disuse of the muscles in question.* Walking thus comes to be performed almost entirely with muscles which act upon the ankle joint, the one articulation of the foot at which movement is still possible; whereas had the toes been allowed perfect freedom of action, the work of lifting the weight of the body from the ground with each step would have been shared by both groups of muscles — those which raise the heel and those which flex the toes. That this is true is shown by the feet of people who have not worn constricting shoes, for in their case the toes are moved freely and perform an important share in locomotion.[1]

If it be asked why the flexors of the toes as well as the extensors of the ankle should take part in the act of walking, the answer is that it is precisely the disuse of the former which leads to their degeneration, so that they are no longer efficient in opposing the tendency of the weight of the body to break down the arches of the foot. It is true that "flat foot" is not the invariable result of this disuse, because some people are so fortunate as to possess ligaments of sufficient strength to hold the bones together despite the pressure of this weight, and also because tightly fitting shoes often assist in holding the bones in position. But it is also true that many others are not so fortunate; one or both arches give way, and some suffer agony as the result. Even if the arches do not break down, the foot is generally unable to stand the strain of prolonged walking without marked discomfort, and it is not too much to say that this weakness of the foot is one of the chief reasons why most people regard a walk of ten or twelve miles as a great task.

[1] The action of each of these groups of muscles may be made clear as follows: With the bare feet take a step forward by first raising the heel and then pushing off by bending the toes downward as far as possible. It will be found that this second movement is capable of assisting to a very considerable extent in pushing the body forward. The student should thus make himself practically familiar with the difference between (1) walking when only the heel is raised and the toes passively bent upward as the step is completed, and (2) walking when the raising of the heel is followed by the *active contraction* of the plantar flexors of the toes.

The hygienic care of the foot in actual practice consists (1) in the use of properly fitting shoes, (2) in avoiding all interference with the circulation of blood in the foot, (3) in maintaining proper conditions of temperature and moisture within the shoe, and (4) in the training and use of the muscles of the foot, so as to keep them functionally strong and active.



A *B* *C*

FIG. 126. Correct and incorrect shapes of the sole of the shoe

Outline of the sole in solid lines; of the natural shape of the foot in dotted lines. *A*, correct shape; in *B* the shape is correct except that the median line of the sole is not straight in the region of the toes, thus pressing the great toe over toward the other toes; *C* has not only this defect but is too narrow

3. Shoes. Among the most important requirements of a good shoe are the following: (1) The sole of the shoe should everywhere be as *wide* as the sole of the foot when one is standing and the feet are warm. (2) The heels should be *low* and *broad.* (3) The sole and uppers should be sufficiently *flexible* to permit without great resistance the bending of the foot at the transverse line of articulation of the toes with the instep. Many shoes, otherwise correct, are faulty in that the sole or the upper from the heel forward is too stiff to permit the efficient action of the toe movements. (4) The inner (or median) side of the shoe should be "straight," that is, the prolongation of the median line of the great toe should touch the heel. Fig. 126 shows the proper and improper shape of the shoe in this respect. Unless the foot is already greatly deformed, no shoe should be tolerated which does not permit the great toe and, for that matter, all the toes to point straight forward, since otherwise it is not easy to flex them. Not only is the "toothpick" shoe a hygienic abomination, but any shoe in which the inner or median side slopes outward toward the toe is highly objectionable (see Fig. 126, *B*). (5) In the region of the toes the shoes should have sufficient room to permit perfect freedom of motion in the toes.

4. Shoes for deformed feet. It must be frankly admitted that shoes which fill all the above requirements are uncomfortable to many feet. But this is only because such feet have already become deformed. In such cases the attempt should be made to bring the foot back toward its normal shape by *gradually* approaching the lines above indicated. With some hopelessly deformed feet this is, of course, impossible, but with many others great improvement is possible.

Upon one point there can be no yielding: *children should wear only properly shaped shoes.* It is a pitiable sight to see the foot of a child, broadening out as it does toward the mobile toes, forced into a shoe which seems to be constructed on the assumption that nature ought to have made the human foot wedge-shaped and that it is man's part to improve on nature.

Recent years have witnessed marked improvement in the shape of shoes. Fortunately it is now possible in many places to buy properly made shoes; but further improvement is still possible, both among those who make shoes and those who buy them. As a matter of common sense nothing could be more absurd than the custom of changing the shape of shoes each season merely to bring out a new style; nor would this be done if people were more generally informed as to the requirements of a good shoe and insisted on having only those which meet these requirements. In so far only as there is a general demand for such shoes in any community, will manufacturers supply them. The remedy lies with the public rather than with the manufacturers.

And this same public must learn that neither from the hygienic nor from the æsthetic standpoint is a small foot with a pointed toe and high heel the ideal foot. Such is not the foot of the Apollo Belvedere nor that of the Venus of Melos. It is simply a deformity, belonging in the same category with the constricted waist, and far more harmful to its possessor than the ear or nose ornaments of the Hottentot. No hygienic lesson is more important than that clothing should fit the body, and not the body the clothing.

5. Interference with the circulation in the foot. By lacing the shoe too tightly, especially around the top, and by the use of tight garters the superficial veins which bring blood back from portions of the foot are often compressed. More or less of passive congestion results, and this not only produces discomfort but introduces in other ways conditions highly unfavorable for the free action of the foot; consequently it is part of the hygiene of that organ to avoid these congestions at all times. Garters should always be adjustable in length to the size of the leg, and shoes should not be laced tightly.

6. Proper conditions of temperature and moisture within the shoe. Although the best of shoes are but poorly adapted to care for the perspiration and to maintain an equable temperature of the foot, some shoes are preferable to others in these respects. Thus any "patent" or "enamel" leather is objectionable for walking, because it is almost impervious to moisture. In such shoes the foot becomes overheated while one is walking, because the perspiration does not evaporate from its surface; and if one afterwards sits still, the feet are apt to become cold because the wet stockings make a good conductor of heat. Because their surface radiates heat with such ease these shoes are cold in cold weather, and because they prevent the evaporation of perspiration they are hot in hot weather. Canvas shoes are the reverse of enamel and are highly commendable for active exercise, especially in summer time.

The "russet" shoe for summer wear is a great boon. The leather of which it is made is as porous as any on the market and because of its color absorbs less heat in warm weather. The failure of the attempt a few years ago to retire these shoes from sale is good evidence that people can get a certain shoe if only they insist upon having it.

In brief, the feet should be kept dry and neither distinctly warm nor cold. Anything which interferes with these conditions should be attended to; shoes and stockings should be changed as frequently as necessary and only such footwear used as maintains as far as possible the ideal conditions given above.

7. The proper physical training of the foot. It is quite possible to meet all the above hygienic conditions and yet have feet which are incapable of doing the work which we have a right to demand of them. As was shown at the outset, the action of the foot in bearing the weight of the body is not a passive but an active one. Muscles must assist in holding the bones in place when one is standing still, and they must *operate* the foot during the act of locomotion. The physical training of the foot therefore consists (1) in securing adequate strength of these muscles and (2) in establishing right habits in using them.

Since the muscles in which strength is especially needed are those which produce plantar (downward) flexion of the toes, we may strengthen these muscles by such exercises as pressing as hard as possible with the toes against the floor or the footboard of a bed, by attempting to "stand on tiptoe," and by the familiar gymnastic movement of "heels raise, knees bend," etc.

Among the habits which should be cultivated may be mentioned, first of all, walking and running with the foot straight forward instead of toeing outward. The bones which form any hinge joint, like that of the ankle, should move in a plane perpendicular to the axis of motion in the joint, and this is possible in the case in question only when the feet are pointed forward. It is absolutely wrong to teach children to toe outward in walking, and they would never do so were they left to themselves and their feet clothed in proper shoes.

In addition to this the habit should be cultivated of completing each step by "digging into the ground" with all the toes. This cultivates the use of the foot muscles in locomotion, along with the use of those which raise the heel, and the habit once acquired and regularly practiced keeps these muscles strong.

Finally, it must be remembered that the training of these muscles, like the training of all muscles, must be a gradual process. Where they have been weakened by improper use, one must proceed to strengthen them little by little from day to day, and in no case make the mistake of imposing upon them work which they are unable to bear. Most cases of "weak ankles" can be cured if taken in time and their muscles *gradually* trained. But these muscles can never be trained by imposing upon them sudden and severe work which, in their weakened condition, they are unable to perform. The fatigue thus induced too often prevents their working at all, thus leaving the weight of the body free to strain ligaments and do other damage which may leave the foot in a worse condition than before.

We have already insisted (II, 313) upon the importance of walking as a means of general muscular activity; and we may urge in concluding this chapter that the chief hygienic importance of the care and training of the feet lies not so much in the fact that the danger of acquiring flat foot is thereby lessened as in the fact that we thereby maintain in good working order this essential part of the mechanism of locomotion. American men, and especially American women, compare very unfavorably with their English cousins in the ability to enjoy walking and tramping; and while this is partly due to the general disuse of walking as a means of exercise, and perhaps partly to our warmer summers and fewer paths and pleasure grounds, it is equally attributable to the deformation of the feet, which robs those organs of the power *and even the possibility* of performing with ease their natural function.

CHAPTER XXV

BATHING

1. The hygiene of bathing. The principal hygienic purpose of bathing may be stated in one word, namely, *cleanliness.* A bath is often stimulating and refreshing, and special kinds of baths may be used upon occasions for good and useful ends; their value in the treatment of many diseases is coming to be widely recognized, and even in health they may be useful as aids to the best working power. But experience shows that it is not necessary, even if it be refreshing, for a healthy person leading a healthy life to use bathing for any other purpose than cleanliness.

The sweat glands and the sebaceous glands pour out upon the skin secretions which primarily serve the useful purposes of regulating the temperature of the body and keeping pliable the horny layer of the epidermis. Each of these secretions contains solid material, which, as the water of perspiration evaporates, is left on the surface of the skin or in the ducts of the sweat glands; some of the solids, too, are either themselves odorous or else are putrescible, giving rise to offensive decomposition products; consequently it is a duty which everyone owes to his fellow man to bathe so as to be clean and *to render that bathing effective by wearing clean clothes.* A clean person, clean clothing, a clean house, clean premises, clean streets, a clean town, are so many forms of that habit of cleanliness which is one of the characteristics of high civilization, one of the fundamental elements of self-respect and proper living.

Besides this, filth and dirt are effective carriers of disease; consequently bathing and the use of clean clothing diminish the chance of infection. Finally, personal cleanliness helps to keep the skin in a healthy condition, and this alone is a sufficient reason for making it a rule in the hygienic conduct of life.

2. The indifferent bath. A bath which is neither distinctly cold nor hot may be said, in general, to answer all purposes of cleanliness. The temperature of such a bath varies between 80° and 90° F. with different individuals. When soap is used, water of this temperature removes the waste products from the skin sufficiently for all practical purposes, especially when such a bath is taken daily. Indifferent baths are, however, without any stimulating (or depressing) physiological effect, provided they are not taken in a cold room; and for some people they are the most advisable form of bathing.

3. The hot bath used alone is generally held to be inadvisable. Many, perhaps most, people find that it is followed by an enervating effect and that caution is required in the subsequent exposure to cold. These effects, however, are generally obviated by following the hot bath with a cold needle bath, a cold shower, or a cold plunge, followed by a good "rubdown," and possibly this procedure may be recommended as the most useful and beneficial form of bathing for the great majority of people. The hot bath serves the purposes of cleanliness more effectively than the indifferent bath, and the shock of the cold bath is not so trying to many people when taken immediately after the skin has thus been thoroughly warmed. Too frequent and especially too prolonged hot bathing, however, is apt to remove too much oil from the skin.

Hot baths, either of the body as a whole or at times a hot foot bath, are often useful in bringing the blood to the skin and thus checking a threatened cold or other inflammatory process. Special care is needed, however, in this case to avoid subsequent exposure to cold. It should also be remembered that a very hot bath is a strong stimulus to the nervous system as a whole.

4. The cold bath is a powerful stimulus to the nervous system. When the irritability of the latter is low, as when we awake from slumber, it "wakes us up," and immediately after it we feel distinct exhilarating effects. In addition to this it probably serves as a training to the heat-regulating mechanism of the body, "hardening" the body to the effects of cold. Undoubtedly its influence with a large proportion of healthy people is beneficial, though, as we shall see, this is not the case with all. Before dealing with this side of the question we may give some rules which are always applicable in the use of such baths.

First, they should not be prolonged. To stay in a cold bath longer than one minute is undesirable save in a very few exceptional cases; thirty seconds is the usual time, while with some people ten seconds is the maximum.

Second, a cold bath should be taken when the skin is warm. Immediately on rising in the morning, immediately after muscular exercise, or immediately after a hot bath it is most beneficial and least likely to produce bad after-effects.

Cold bathing should always be followed, except in warm weather, by a good rubdown with a rough towel. This promotes a good flow of blood through the skin and adds to the tonic effects.

A cold bath should not be taken in a cold room. Many profit by its use in summer, but experience undesirable effects in winter.

Third, cold bathing should not be used unless it is followed by what is called the "reaction"; that is, unless it produces a distinct glow in the skin. The persistence of pallor in the skin after the rubdown is proof that the system does not react properly, and is a warning that this form of bathing should be given up or at least modified. This does not mean that the bath necessarily agrees with us if it does produce the "glow," for this is only one of its after-effects, and we must judge of its usefulness not by one but by the sum total of the effects produced.

Fourth, no bath, unless it be possibly the indifferent bath, should be taken within an hour or more after a meal. The evidence of experience on this point is so unmistakable that nothing more need be said about it.

It would be a mistake to discourage all bathing except that which is used for purposes of cleanliness; and when we insist that both hot and cold baths are an artificial element introduced into the environment, it is only to enforce the need of carefully observing the effects of their use. No one is justified in saying that these baths are necessarily good for all healthy people; no one is justified in recommending them as essential elements in the hygienic conduct of life. They must be judged by their effects, and when submitted to this standard it would appear that while they are beneficial to some people they are harmful to others.

We must furthermore distinguish between the immediate results, those noticed later in the day, and the remote results. The immediate effects may be exhilarating; we may "feel splendid" afterward, and yet this feeling may be succeeded by one of depression. At times cold bathing on rising in the morning results in constipation, although the bath itself may be enjoyable. This may be exceptional, but it shows that everyone must determine for himself the value of the bath by the sum total of its after-effects and not alone by those which accompany or immediately follow it.

5. Swimming and salt-water bathing. When one is swimming, the heat produced within the body by muscular exertion counteracts to some extent the effect of the cool or cold water applied to the skin. Hence it is possible to remain in the water a longer time with safety and even with profit than in the ordinary cold bath. It is quite impossible, however, to give definite rules as to the length of time one should remain in the water, since this depends on the amount of muscular activity, on the temperature of the water, and on the condition of the bather. But the hygienic value of swimming and sea bathing must be determined by the same tests as have been urged in the case of cold bathing in general.

It is also important to remember the danger of going into cold water when one is fatigued from muscular exertion. The fatigued muscles seem especially liable to go into cramps under these conditions, and persons have been drowned in this way before help could reach them.

When one takes vigorous daily exercise the best time for the bath is immediately after the exercise. One is then in a perspiration and it is best to change the clothing. The skin is most readily cleaned in this condition, and most persons find a hot bath, with or without the use of soap, followed by a short, cold needle bath, shower, or plunge, preferable to other forms of bathing. The time for bathing, however, like the time for eating, must depend on one's work in life. We do not live to bathe, any more than we live to eat.

CHAPTER XXVI

CLOTHING[1]

1. The hygienic object of clothing. Even in the savage state some races clothe themselves thoroughly. The Eskimos, for example, go warmly clad in furs, and the wild Indians who once inhabited the northern United States wore, at least in winter, the skins of animals. In the tropics, on the other hand, as in northern Africa or the islands of the South Seas, very little clothing is worn, and that more for the sake of decency or ornament than for warmth. In these facts we find *the hygienic reason for the use of clothing*, namely, *to aid the body in maintaining its constant temperature.* In cold weather, clothing is a kind of portable house, a close and intimate shelter, an indispensable aid to the skin in preventing undue loss of heat; on the other hand, summer clothing should interfere no more than is unavoidably necessary with the dissipation of heat from the skin. If, in winter, warm days come, or if the body becomes heated by muscular activity, or if (as too often happens) houses or public places are overheated, then winter clothing may not only become a burden but may be actually unhygienic. Conversely, if in a changeable climate cold days or nights come in summer, or sea winds blow damp as well as cold, then ordinary summer clothing may prove to be insufficient. Here, as always, the individual must be the watchful guardian of his own welfare.

[1] The student is advised to review Part I, Chapter XII, before studying this chapter. Chapter XXI, on the Prevention and Care of Colds and Some Other Inflammations, may also be profitably reviewed.

Clothing affects the temperature regulation of the body by its influence upon the loss of heat from the skin; and the two channels of this heat loss are (1) heat transfer to colder objects and (2) the evaporation of perspiration.

1. *Clothing and the transfer of heat.* Any fabric whose texture permits the air warmed by contact with the skin to be replaced readily by colder air from without will obviously favor the cooling of the skin; and conversely, any garment which lessens or altogether prevents these currents of air through it is to that extent a warm garment. The leather hunting jacket lined with wool or fur is especially warm, and a newspaper under one's coat or jacket similarly affords a large measure of protection against cold. On the other hand, a rubber coat may be very uncomfortable on a warm day, although the effect in this case is due to its interference with the evaporation of the perspiration as well as to the prevention of the passage of air through the garment.

Even apart from the passage of air through the clothing, heat may, of course, be transferred from the skin to the outer air, and some fabrics transfer heat more readily than others. Other things being equal, *the rate at which clothing transfers heat depends on the amount of air within its meshes.* Thus wool is warmer than cotton not because of any difference in conductivity of the two kinds of fibers but because when wool fibers are made into yarn their stiffness and elasticity keep them apart, so that garments woven from this yarn always contain spaces filled with air, which is a poor conductor of heat. Moreover, the same properties of the fibers prevent their being pressed and felted together in laundering, as ordinarily happens with cotton and linen fabrics. We shall see that cotton and linen may be so woven as to avoid this result, as in many "meshwork" fabrics, but they are not usually so woven.

A moment's thought will show that the warmth of a dry garment will depend on the size of its meshes. These may be so fine and close as to inclose an insufficient quantity of the nonconducting air, or they may be so large as to permit too free circulation. It is also clear that the warmth of a garment is not determined by its weight or thickness alone.

2. *Clothing and the perspiration.* So long as the meshes of a fabric contain air, heat is conducted but slowly from the skin. When, however, this air is partially or entirely replaced by water, the fabric transfers heat from the skin much more rapidly, and if the surrounding atmosphere is distinctly colder than the body, the skin becomes chilled and internal organs congested; hence the danger of wet clothing.

More important still is the relation of clothing to the evaporation of perspiration. We have learned that perspiration is useful to the body *only as it evaporates.* Consequently the clothing should be such as will *permit the perspiration to evaporate almost as fast as it is secreted.* The skin will thus be cooled at the time that the needs of the body require such cooling, and the clothing will not remain wet after the secretion of perspiration has ceased and the need for cooling the skin no longer exists. Or if it is not possible to secure this rapid drying, the fabric should contain, even while moist, a considerable quantity of air within its meshes, thereby checking the loss of heat from the skin.

2. The clothing worn next the skin and the outer clothing. Consideration of the above relations of clothing to heat transfer and to the evaporation of perspiration shows at once that the clothing worn next the skin must fulfill requirements not demanded of the outer clothing. The sole hygienic purpose of the latter is warmth, and the fabric should be chosen accordingly. In warm weather, in well-heated rooms, and during muscular activity warm outer clothing is undesirable; on the other hand, when the body is exposed to cold and is not at the same time engaged in muscular exertion, the outer clothing should be chosen for warmth; for this purpose woolen fabrics are superior to all others.

The clothing worn next the skin must, in addition, care for the perspiration. For those forced by age or other physical disability to lead sedentary lives, woolen underwear is very useful in cold weather. Since in the case of such persons the blood is not brought to the skin by muscular activity, it is necessary that the skin be kept warm and internal congestions prevented. For such persons woolen fabrics are probably superior to all others. Moreover, during exposure to extreme cold, when little or no perspiration is secreted even during vigorous muscular work, woolen underwear is superior for everyone because of its greater warmth.

For healthy people, however, in the full vigor of life, taking daily muscular exercise but not exposed to extremes of cold, woolen underwear presents many serious drawbacks. In the first place its very warmth is objectionable during muscular activity, because it makes more difficult the discharge of the surplus heat. In the second place, wool absorbs the perspiration very slowly and so prevents its evaporation from the outer surface of the garment; the perspiration does not cool the body as it should, but remains between the skin and the garment — an unhealthful condition for the skin. In the third place, when the garment has once become "wet through," that is, the air within its meshes has been largely displaced by water, it dries more slowly than a linen or a cotton garment.

It is better, in other words, for healthy people to depend upon the outer clothing, including overcoats, etc., for warmth, when protection against cold is needed, rather than upon even moderately heavy underwear. In this way it is possible readily to relieve the body of its heavier clothing when it becomes necessary to get rid of surplus heat, that is, in warm rooms and during muscular activity in only moderate cold weather, and yet to protect one's self against cold when such protection is necessary.

Of late years the attempt has been made, with considerable success, to weave linen, and even cotton, so as to contain fairly large meshes between the threads. The perspiration is rapidly brought to the surface of the garment *through the threads* by capillary attraction and so evaporates quickly; for this reason the garment dries readily and, even while wet, usually retains a considerable quantity of air within its meshes.

The thickness of underwear, as well as of the garments worn immediately over it, should be determined by the amount of exposure to cold *when at rest.* When our houses or offices are properly heated (65° to 70° F.) in winter heavy clothing is as much to be condemned as the too common overheating of our rooms, and for the same reason. When, on the other hand, our work is out of doors in cold weather but involves only a small amount of muscular activity, warmer clothing should be worn; in this case the use of heavy woolen underwear is advisable.

It is unnecessary to go further into details. The student can solve special problems for himself, always remembering that proper clothes are such as will prevent undue loss of heat and consequent chilling of the skin (with accompanying internal congestions) when the body is at rest.

3. The outer clothing. Of this little need be said. By varying the thickness of the outer clothing we adapt it to the conditions of life. It must also be chosen with reference to its permeability to air. In hot summer weather it should be as thin and porous as possible; in winter it should protect from wind. When still further protection is needed, it may be obtained by the use of overcoats, gloves, muffs, lap robes, or other wraps.

Some people do not use sufficiently warm clothing in cold weather, but most adults make the opposite mistake. The custom of using very thick clothing in cold weather appears to have been inherited from the time when houses were poorly heated, when transportation from place to place was in cold cars or carriages, and when, in general, the human race was more exposed to cold than it is to-day. Where these conditions prevail, as they still do in many country districts, heavy clothing should no doubt be worn in winter. The same may be said of driving in open vehicles, such as sleighs, etc. But in cities, where houses are more likely to be overheated than underheated, where steam and electric cars are far from being chilly, where, in short, we need not generally be exposed to cold except when walking or taking other muscular exercise, the main dependence for protection against cold should be upon the outer wrappings rather than upon the underwear — the coat and trousers, or the dress. We do not change to heavy clothing in summer when the thermometer falls to 65° or 70° F., and there is no reason why we should use such clothing at these temperatures in winter. The precautions which many take against sudden changes of weather are often excessive.

4. Clothing not the only protection against cold. It must be remembered that we have another means of protection against cold besides clothing, and that is muscular activity. Even if, as often happens, a balmy morning passes into a chilly afternoon, most people, especially those living in cities, should be able to keep warm by a brisk walk when going home; a little exposure to cold will not harm, but will rather harden, a healthy man or woman. If we are tired out and ought not to walk, we can usually ride in a heated car. To wear heavier clothing than the probable necessities of the case demand, merely because there is a chance that suitable weather for such clothing may overtake us, is in general unwise. Oppressed with its weight and warmth, the usual result is a disinclination to any vigorous muscular activity while out of doors, and this in the long run is more harmful than a comparatively brief chilling of the skin.

5. Clothing should not be heavy. The reference in the last paragraph to the burden of heavy clothing deserves further consideration. The terms "warm," "thick," and "heavy," as applied to clothing, are often used as if they were synonymous, although a thick garment is not necessarily a heavy garment, and a thinner but more loosely woven coat may be warmer than one which is thicker but more closely woven. In the selection of clothing it is always advisable, not only as a matter of personal comfort but also as a matter of practical hygiene, to avoid heavy fabrics. While this holds especially for invalids and elderly people, to whom the burden is more oppressive, it also holds for the young and strong. The clothing should be such as will interfere in the least degree with the freedom of bodily movements. Not only should everyone avoid such fashions as tight lacing and high-heeled boots — so senseless as to be beneath the contempt of those who respect the human body and care for its physical well-being — but care should be taken to have the clothing everywhere loose enough to be comfortable and, above all, light enough so that its weight is not a burden. For this reason a very close weave is objectionable except in windy weather, since it gives great weight of fabric with but small air contents.

DOMESTIC HYGIENE AND SANITATION

CHAPTER XXVII

THE HOUSE: ITS SITE, CONSTRUCTION, FURNISHINGS, AND CARE

1. The family a private community. Every human being has not only individual, or *personal*, relations with his environment but also various other, and *public* relations, since the life of an individual is always more or less closely connected with the lives of other human beings. Each individual or person is a member of some family and also of some village, town, city, state, or nation. Connections of this kind constitute kinship, relationship, and fellowship and are commonly described as social relations (*socius*, "a fellow"). They are nowhere more conspicuous than in matters of life and death, health and disease. The human infant is absolutely dependent upon parental care, and among civilized people the sick, the aged, the dying, and the dead must be tenderly cared for by those who are alive and well. But this is not all, for sickness is frequently "catching," and plagues, pestilences, and epidemics have often run like wildfire through families or communities, leaping from person to person and from village to village very much as a forest fire leaps from tree to tree.

A fundamental feature of all social relations is the fact that persons in families, villages, towns, cities, states, and nations have and use many things *in common.* This has caused such groups of human beings to be known as communities (*communis*, "common"). Of all communities the simplest, the most fundamental, and the most important is the family, or household, in which the various individual members share a common shelter, a common fireside, a common table, and a common interest, based upon the all-powerful ties of blood or marriage. In these and many other respects the family is not only a community but a peculiar kind of community, namely, a private community. But precisely as the individual necessarily has relations to the world outside himself and is by nature not merely a man and an animal, but a social man and a social animal, so the civilized family, or household, although essentially a private establishment, has certain *public* relations. It must draw its air supply from the aërial ocean common to all mankind; it must form a component unit in some village, township, state, or nation; it must buy sugar or salt, tea, coffee, or spices, from overseas.

Midway between the more purely public relations which we shall presently discuss under *public hygiene and sanitation* and those individual relations which we have considered in the foregoing chapters on *personal hygiene* stand the hygiene and sanitation of the house and the family, subjects neither altogether public nor altogether personal. These we may describe as *domestic hygiene and sanitation.*

2. Housing and the house. The chief function of clothing is to protect the body from cold by maintaining about the skin fairly constant temperature conditions, and accordingly clothing is of least importance in the tropics, where conditions of temperature are both constant and warm. The housing problem is very similar, for the principal function of the house is likewise to furnish for the body a favorable environment and, especially, a fairly constant temperature. Here also the problem is simplest in the tropics. The house, in fact, is a kind of outer clothing or protective shell, although usually designed not for a single individual but for an entire *family* or, as in the case of tenement houses, apartment houses, or hotels, for many families or for the public.

Houses may be separated and detached, as on farms or in villages, or massed in groups or blocks, as in towns or cities; and owing to the fact that they are comparatively durable and costly, most people live in dwellings already built. But although very often a family cannot build its dwelling, but must take to some extent what it can get, it usually has, sooner or later, some choice; and even if it has not much choice, it may modify more or less from time to time the domicile which it must occupy.

3. The site of the house is often determined more by necessity, taste, or convenience than by hygienic considerations, but in general it may be said that a human dwelling should be so situated as to afford good air, good light, good drainage, and good neighbors. If, in addition, beautiful, charming, or attractive surroundings can be had, these are of great importance, since beauty and charm often have a distinct hygienic value. A certain seclusion or privacy is also to be desired, for a quiet, retired, and restful home, removed from the distractions of publicity, is soothing to tired nerves as well as conducive to normal and wholesome family life. On the other hand, extreme isolation, such as is sometimes found in farmhouses, often produces a morbid feeling of loneliness.

When possible the house should be placed upon *open, porous*, or *gravelly soil*, because such soil is less likely to be water-logged and is more easily drained. In the United States in general a *southerly* or *southwesterly slope* is usually preferable, as affording more sunshine in winter and more breeze in summer. It is also wise, of course, to have the principal living rooms on the side exposed to dry, rather than to cold and damp, winds.

Good air for a house is to be sought for in a clean neighborhood, a clean, dry cellar, and a free circulation — the latter impeded as little as possible by other buildings or, in the country, by too many trees. An *elevation*, therefore, rather than a depression is obviously desirable as an aid in securing these things, although the very top of a hill should usually be avoided because of its bleakness. A *dry cellar* and, if possible, a dry, open, and porous soil beneath the house are highly important, no matter where the house is placed. Cellar habitations are very objectionable and ought to be avoided by even the poorest family. Such dwellings were long since forbidden by law in England, and although sanitarians are not yet agreed as to all the reasons why cellar habitations are injurious, the principal reasons seem to be the well-known unwholesomeness of dampness and want of sunlight. Undue dampness in air is believed to favor rheumatism and other disorders, and the absence of sunlight not only favors dampness and microbic life but also tends to mental depression. House cellars should be well drained.

Good light and, if possible, *abundant sunshine* are hygienic conditions of great importance, both as aids to cheerfulness and happiness and as powerful sanitary agents. Sunshine tends to remove dampness and to destroy the germs of infectious diseases. In winter, sunshine is valuable also for warmth.

Good drainage is no less (and perhaps no more) necessary for human habitations than good air and good light. With the abundant use of water in recent times for washing, bathing, cleaning, sewage disposal, and other purposes, it becomes necessary in modern houses to get rid somehow of a great deal of soiled and dirty water, and the possibility of easy and safe drainage or removal of such water must be kept in mind in considering the sanitary aspects of the situation of any house, old or new. Here again the advantage is plain of some elevation of site.

4. The construction of the house. As the first object of any house is shelter from rain, snow, wind, dampness, and excessive heat or cold, its materials should be waterproof, windproof, and nonconducting for heat, as far as is consistent with a proper circulation of air. Wigwams or tents, at least in temperate latitudes, are clearly defective in some of these particulars. Houses built of glass or india-rubber would answer most of these requirements but would still be most unhygienic, chiefly because glass houses would be too light and too hot, while both glass and india-rubber would interfere seriously with that free circulation of air which takes place through relatively porous materials such as wood and brick. Buildings of wood, stone, brick, or steel and brick, rightly built, answer all requirements. A "double wall," that is, a hollow wall, by providing a nonconducting air space, is of great value for preventing rapid changes in the temperatures of houses under sudden changes of climate, as well as for protection against dampness and noise.

Much circulation of air usually takes place even through walls or partitions of plaster and wood, and a knowledge of this so-called "natural" ventilation helps us to understand how it is that many people live and even thrive in seemingly unventilated rooms and houses. It also helps us to understand how the damp air of a cellar finds its way upward into a house and why a double floor (with air spaces between) is especially useful immediately above the cellar. Blinds or shutters and shades or curtains for darkening rooms are of great hygienic value, since sleep is deeper in darkness than in light, and in summer these tend also to keep the house cooler.

5. The furnishings of the house. The *walls* of rooms may be of wood — bare, painted, or varnished — or of plaster, either bare or covered by textiles such as burlap, tapestry, or paper. Sometimes, instead of being papered, walls and partitions are painted either with white paint or in colors, and sometimes simply a hard finish is given to plaster, which is afterwards "whitewashed" or "calcimined."

A good feature of painted walls is the fact that they may be washed, and of walls smoothly calcimined that they may be easily done over. In general, a smooth and washable surface is preferable to a rough one or one injured by washing, for these not only collect more dust but are harder to keep clean.

The most serious charge, from the hygienic point of view, thus far brought against *wall papers* is that of the danger of poisoning for persons living in rooms papered with such papers as contain arsenic. The evidence of such occasional poisoning seems now convincing, especially since the work of Gosio, an Italian investigator, showed that molds or other microörganisms which grow in the paste used to stick the paper to the walls are capable of attacking the arsenic of some coloring matters, thereby producing volatile compounds of arsenic readily diffusible into the air of the room.

There is similar danger from arsenical poisoning in some tapestries or furniture coverings, and grave disorders have been attributed, apparently with reason, to this source.

The *iron bedstead*, light, firm, cheap, and easy to keep clean, is a marked improvement upon the heavy wooden bedsteads formerly used. Curtains, canopies, valances, etc., either above or below beds, are objectionable, as they interfere with the free circulation of air. The modern open bedstead is an improvement upon the old-fashioned "four-poster," with its hangings, almost as great as is the modern "open" over the earlier concealed plumbing.

Single beds possess many advantages over double beds. They are more easily cared for and kept clean; the amount of covering can be more accurately adapted to the individual needs of their occupants, who are also less exposed in cases of infectious disease; and the use of such beds is more conducive to undisturbed slumber.

Folding beds, *mantle beds*, *sofa beds*, and all similar devices for concealment of beds and bedding are subject to the objection that they are likely to be closed too soon after having been used and before the bedding has been sufficiently aired or freshened.

Floors are in America usually wooden and made of boards, "matched" or otherwise laid tight. Formerly the material used for inexpensive floors was of pine, spruce, hemlock, or other soft woods, oak being reserved for the more costly *hard floors*. Nowadays hard pine (Southern pine) is much used, and many cheap yet good floors are made of this material. *Softwood floors* are apt to become dented and splintered unless covered and protected by carpets or mattings; but if made of good stock and well cared for by frequent painting, such floors answer very well for a long time, especially in rooms, such as chambers, not subject to hard usage. *Bare floors* possess the immense sanitary advantage of being easy to clean and also of revealing dust and dirt, but they require, for the latter reason, more care and are also open to the objection that they are comparatively noisy.

Fixed mattings are useful for the deadening of sounds, and *fixed carpets* not only for this but also for warmth, but both hold dirt and are hard to clean, while light, *movable mattings*, *carpets*, or *rugs* readily lend themselves to cleanliness, because they can be removed and in their temporary absence both they and the otherwise bare floors upon which they rest can be thoroughly cleaned.

6. The care of the house. The house is subject to the wear and tear of time and weather. Painting, in the case of wooden houses (and for the steel parts of steel-and-brick structures), and pointing (or the renewal of mortar between bricks or stones), in the case of brick or stone houses, help to make them waterproof and windproof and tend to keep out dampness.

The *cellar*, especially, requires watchful care and should be kept not only *dry*, by windows or other ventilating devices opened wide in favorable weather, but also *clean* and free from rubbish, decaying vegetables, or anything tending to dirt or dampness.

The *halls*, *stairways*, and *rooms* and the furniture, radiators, etc. they contain should be kept as free from dust as possible. Former crude methods of sweeping and dusting are fortunately giving place to more effective ones, and the feather duster, which merely transfers dust from one place to another and stamps the individual using it as superficial, indolent, or shiftless, is only seen occasionally. A damp (not a wet) cloth or, even better, a cloth upon which a harmless volatile oil has been sprayed, will remove dust from books and furniture without stirring it up to settle elsewhere. The various forms of vacuum cleaners are ideal for floors, rugs, and carpets, and efficient hand-power vacuum cleaners can now be obtained at a comparatively low price. The more expensive forms, operated by electricity, are more effective and less tiring to operate; special attachments also make electric vacuum cleaners applicable to books and furniture as well.

Another method which has much to commend it for special uses consists in spraying into the atmosphere and even on the walls of a room a harmless volatile oil in the form of a very fine mist, discharged from an atomizing spray. As this mist settles to the floor, it catches the particles of dust, which can then be removed by a broom covered with a cloth without causing the dust to rise. After this treatment the dust on the walls may be effectively removed by a long-handled brush. Painted and varnished surfaces are also often improved by rubbing with a cloth moistened with a volatile oil.

Even when closed, houses quickly become dusty or dirty, because the air which finds its way into them through cracks or crevices is almost always more or less charged with dust, while the occupants of inhabited houses bring in upon clothes, shoes, and all kinds of articles more or less dust or dirt. Fires, whether in stoves, fireplaces, or furnaces, also add greatly to the dust of houses. Dust and dirt are composed largely of inorganic or lifeless matters but also partly of microbes. Most of the latter are harmless, and some kinds of dust and dirt are of little sanitary importance — a fact which helps us to understand why some people seem to have health even in dirty surroundings. But dust and dirt sometimes contain the germs of dangerous diseases, and the way of safety is the way of cleanliness.

The same principle may be applied to other matters connected with the care and management of the house. Rats and mice are for the most part merely troublesome pests, destructive of property and food; on the other hand, they (at least rats) may be the means of conveying disease (see Chapter XXXIII). Consequently, by keeping the premises as free from them as possible, or even by making the house rat-proof, we lessen the chance of contracting communicable disease. Similar considerations obviously apply to screening the house against mosquitoes and flies, which, although generally nothing more than annoyances, may nevertheless at times be the carriers of dangerous diseases.

CHAPTER XXVIII

THE WARMING AND LIGHTING OF THE HOUSE

1. The warming of the house. The earliest method of warming human dwellings was the open fire, in hut, cave, or wigwam, and when chimneys were added to carry off smoke and improve combustion by creating drafts, the open fire still remained for a time the sole resource of mankind for heating purposes. It is still the most attractive and most cheerful method of heating and has been well called "the eye of the room." It is a coveted luxury in all tasteful homes, not so much for the heat it furnishes as for its cheerful glow and the constant interest which it excites. The *home* and the *fireside* have become everywhere almost equivalent terms.

2. The open fire may be of either coal or wood. In England it is almost always of coal, and in that country it is still the principal means of heating. In some other countries, especially in the United States, it is made of either coal or wood, but is less depended upon for heating purposes. The open fire may be on a hearth in a fireplace or in an open grate or an open stove. In all modern cases of true open fires a chimney rises above the fire to carry off the smoke, and the draft of the chimney (caused by the rising of the column of lighter, heated air) constantly sucks away the air of the room and produces considerable ventilation by removing vitiated air. The air thus removed is replaced by air from adjoining rooms or from outdoors, driven in by the atmospheric pressure through open doors or windows or through the walls themselves, which, if of wood or plaster or even of stone or brick, are to some extent porous. But while such ventilation has great advantages and is one of the best things about open fires, such fires are wasteful of heat and often do not effectively warm the entire room. This is because the warmed air is not returned to the room, but is drawn up the chimney, and because the movement of the cold air which is pressed in from the outside tends to make the room "drafty." Radiation from the fire itself, rather than convection by air currents, thus becomes the chief means of warmth; and the complaint against open fires that those gathered about them, whether indoors or out, are "roasted in front and frozen behind" is undoubtedly well founded. Open fires, nevertheless, serve admirably to "take the chill off" from a room in those days of late spring or early autumn when the temperature is only a few degrees below the proper point (see p. 204).

3. Stoves are superior to open fires as sources of warmth, but far inferior in attractiveness and as aids to ventilation. A stove is usually placed in a room at some distance from the wall and connected with the chimney by a stovepipe to carry off the products of combustion. There is no such thing as an "air-tight" stove, a term often used because some stoves seem tightly closed, only enough air being allowed to enter to supply the actual need for combustion. A stove warms a room by the mixture of currents of heated air around the stove with the cooler air in other parts of the room (that is, by convection) and also by direct radiation from the stove itself.

4. Hot-air furnaces are usually inclosed stoves placed in the basement or cellar. They are provided with smoke pipes and surrounded by a space (the hot-air chamber) to the lower portion of which a pipe, or "air box," conducts cold air, while a second pipe or system of pipes leading off from the upper portion of the chamber supplies the various rooms with the warmed air. This is a convenient, economical, and popular method of heating a house, and possesses the great advantage of bringing constantly into the various rooms supplies of fresh air. If this air has not been overheated while passing by the furnace, little objection can be brought against it on any ground. It is true that having been warmed its relative dryness has been increased, but this condition may be corrected to some extent by always keeping in the hot-air chamber of the furnace a vessel of water for evaporation.

If, however, the air supplied to the furnace is not fresh and drawn from the outer atmosphere, but is simply taken from the cellar in which the furnace stands; or if the furnace is not tight, but cracked or loose-jointed, so that the gases of combustion may escape and mingle with the air as the latter flows through the pipes and rises into the rooms of the house; or if, as often happens, the air is overheated and greatly overdried, then furnaces of this kind may, and do, become objectionable. In very cold and windy climates, and for houses in bleak or exposed places, furnaces are less satisfactory than steam or hot-water heaters. As they usually deliver warm air under very small pressure, it is often impossible, especially in windy weather, "to put the heat where it is wanted," a difficulty not encountered in the use of steam or hot water. Another objection to hot-air furnaces is the fact that much dust finds its way in with the warm air, but fresh air without dust, at least in towns and cities, is rare.

A simple combination of stove and furnace is much used in some places, where a stove (usually in or against the fireplace) on the first floor heats not only the room in which it stands but also, by means of a pipe (or pipes) and registers, one or more rooms overhead. Unfortunately the air thus supplied to the upper rooms is not always pure air from out of doors; sometimes it is the already vitiated air of the room below.

5. Warming by steam and by hot water. It is very common in the United States to find houses (and other buildings) heated by steam or hot water. Through the "radiators" or "coils" placed in the various rooms there is maintained a circulation of steam or of hot water from a "heater" below. Here the room is warmed partly by direct radiation and partly by convection currents, very much as in the case of the stove. The chief objection to this method of heating is that the heating and the ventilation of the room are not effected by the same process; the room must be ventilated by opening windows, and the air thus introduced is apt to be cold and to produce undesirable drafts. On the other hand, steam and hot water are both superior to hot air in convenience and efficiency. They can be carried anywhere and are free from disturbances by atmospheric conditions, wind pressure, natural ventilation, etc., which greatly interfere with the proper distribution of hot air.[1] Sometimes a combination of direct and "indirect" radiation[2] is employed, the latter being used for all ordinary heating, and the former kept for aid in extremely cold or windy weather. On this plan fresh air drawn from outside is first passed over coils of pipes placed in a basement or cellar and containing steam or hot water, and then carried (as in the hot-air furnace) to the various rooms which it is desired to warm. In addition, radiators are placed in these rooms, often near doors or windows, and in extreme cold weather are charged with steam or hot water to furnish supplementary heating by direct radiation.

6. Oil stoves, gas stoves, and electric heaters. These do not greatly differ from other stoves except in the sources of the heat which they provide and in the important fact

[1] The hot-water system is rapidly coming into favor to replace steam heat, because a given volume of water will carry a larger amount of heat than the same volume of steam; consequently the water can be sent from the heater at a lower temperature than the steam, the supply pipe is not so hot, and the heat is more evenly distributed through the house.

[2] "Indirect radiation" is, of course, really *convection*.

that in the first two the products of combustion are not usually carried off by chimneys but, as in oil or gas lamps, escape directly into the room and thus tend to vitiate its atmosphere without causing any compensating ventilation. In the case of gas stoves special care must be taken to see that the unburned gas does not escape into the room from leaks in the connections or elsewhere. Here the same considerations apply as in the case of gas used for lighting. The flexible rubber tubes often used for supplying gas stoves deteriorate with age and then frequently permit the escape of gas directly into the room. Whenever possible, permanent (metallic) connection of the stove with the iron gas pipe is advisable. Where rubber connections are used, *the gas should always be turned off at the cock on the main pipe, never at that on the stove.*

Electric stoves, like electric lights, are heated by electricity, and even electric lights, though inferior in this respect to oil or gas lights, are often noteworthy factors in the warming of houses. Stoves used for cooking add materially to the warmth of houses, and hence gas or oil stoves may be used with advantage when, as in summer, heat is undesirable.

7. Solar heating; glass verandas. Less use is made of the direct heat of the sun than is often advisable or advantageous. Rooms flooded with sunshine are always more economically warmed than those without it, and a *solarium*, or glass-covered room or veranda, on the south side of a house is often useful as well as agreeable in winter. If provision is made for heating it at night and in cold and cloudy weather, it may be made to answer also as a plant conservatory, or greenhouse, and thus become a source of added interest and pleasure.

8. Overheating. If the temperature of the house is too high we suffer from many of the objectionable conditions of hot weather; mental work is more difficult and we are disinclined to muscular exercise. It is probably unwise to keep the temperature of the house above 68° or 70° F. A good rule is to keep it between 65° and 70° F. (see pp. 201–206). Those who, by reason of infirmities of age, cannot enjoy regular muscular activity often find rooms of this temperature too cold, but they should be encouraged and even urged to keep up at all hazards the habit of doing some muscular work every day. With careful attention to muscular exercise and outdoor life they not only can endure but also enjoy lower room temperatures than is generally supposed, and thus permit the younger members of the household to live under more wholesome temperature conditions. Appetite is also improved by this practice and old age made in general more comfortable and more cheerful. Youth should remember, however, that the aged, largely because they cannot "get warm from the inside," not only desire but actually require warm clothing and often very warm rooms.

9. The lighting of the house. The firelight and the light of the pine knot with which the hut, the hovel, or the wigwam were lighted were objectionable chiefly because of their inconvenience, smoke, and flare or flicker. The invention of the lamp without chimney and of the candle marked a step forward, though their light was weak and flickering. A much greater advance was the invention of the lamp chimney, as it provided what nothing else had done — steadiness of flame — and avoided flare and flicker. Once the latter was overcome it became easy to improve the fuel, until now the oil lamp with chimney not only illuminates and decorates the home of wealth but also brightens and cheers the hut of the fisherman and the cabin of the sailor; it aids and comforts the seamstress in her toil in the humblest lodging; it warns the mariner by night from dangerous coasts by lighthouses, and throws about the student a warm and cheerful radiance as he "burns the midnight oil." Candles are still much used both in churches and in houses, but chiefly because of sentiment or for decoration. They still furnish the softest and most beautiful light, especially for quiet places, but they are unfit for reading purposes because of their flickering and feebleness.

The introduction of gas lighting was a great advance over lighting by lamps, owing to its convenience and cleanliness and the intensity of the light afforded. But gas lights, unless provided with chimneys, are generally unsteady and therefore objectionable for use in reading. Gas lights (and oil lamps) also produce much heat, and by this as well as by their products of combustion may greatly vitiate the air of rooms in which they are used.

While some kinds of *illuminating gas* are more poisonous than others, all manufactured — as distinguished from "natural" — gas contains a considerable percentage of poisonous constituents. When the gas is burned, these are oxidized and form harmless substances, and hence there is little or no danger from the products of its combustion. But the greatest care should be taken to avoid the entrance in any way of unburned gas into the air of a room. This may happen by the gas escaping through leaky fixtures. It may also occur when the light has been turned down very low in the sleeping room and is afterwards blown out by a draft or goes out because of lessened pressure in the main, and the unburned gas escapes freely when the pressure is restored. Still another source of danger exists when the cock used to turn off the gas works too easily in its socket and so is capable of being turned on by slight jars, touches, etc. The student is referred to Chapter XXXIV for a full description of the dangers of inhaling unburned illuminating gas. Illuminating gas is also explosive when mixed with air in certain proportions.

Electric lighting is in many respects an ideal method, giving a convenient, steady, and powerful light; but, as is stated in the next paragraph, care must be exercised that such light is not too bright.

10. The best light. Probably there is no one kind of light which is best for all purposes. For general illumination of public squares and public buildings the electric light seems to be generally preferred. The same thing is probably true of private houses. For reading and for microscopic work, on the other hand, the electric light may easily be too bright; but this objection can be overcome by using lamps of proper candle power, by having the lamp at a suitable distance, or by using bulbs with ground glass. The same thing may be true of the light yielded by any incandescent solid, such as the "lime" (oxyhydrogen) light and the various "mantles" made from incombustible earths, such as that in the Welsbach light. In general, for reading a "soft" light is best, and it is desirable to have the larger part of the light come to the book indirectly from the ceiling or walls rather than solely and directly from any source of light near by. For this reason dark-colored walls are objectionable for rooms in which a number of people do much reading, sewing, or other near work.

CHAPTER XXIX

THE AIR SUPPLY OF THE HOUSE. VENTILATION

Besides the relatively permanent furnishings and fixtures of the house, there are other necessaries of civilized domestic life, such as air, water, oil, gas, coal, and provisions, which come into the house only to be consumed, their waste materials being cast out again. These are commonly called the *domestic supplies*, — air supply, water supply, gas supply, etc., — and they are usually derived from much larger, *public supplies*, which are used in common by many families. All such public supplies, although convenient, may, under certain circumstances, become dangerous to human life and health.

1. The air supply of the house is probably more neglected than any other. Water, gas, coal, and provisions are costly and often difficult to get, but air is always abundant and cheap. The familiar saying "as free as air" applies best, however, to outdoor air; for, as we shall see, good air in houses is not always very abundant nor always cheap and easy to provide.

Inasmuch as the adult human body requires for its regular uses about five hundred cubic inches of air per minute, the air in the immediate vicinity of the nose is quickly used up; and as an equal amount of vitiated air is discharged per minute at the same place, the need is obvious of a constant streaming of air about the body which shall remove vitiated air and supply fresh air. This circulation or flow of air is just as necessary as is the circulation of the blood; but as the movement always goes on unseen, through the diffusion of gases and by other natural and invisible agencies, it is harder to realize the need. Out of doors the air supply is ordinarily sufficient and of good quality, especially while the body is in motion.

2. Stagnant air. Conditions are very different indoors. Life is more sedentary, the body is more quiet, and natural wind currents or drafts are intentionally prevented; the air of houses tends to become stationary and even stagnant and with it the air supply about the bodies of the house dwellers. Since it is this stagnant air which is steadily vitiated by the air discharged from the nose and mouth, a blanket of increasingly stagnant and impure air tends to accumulate about the body of a sitting or sleeping person. To prevent this stagnation and the consequent impurity of the air supply, movement of the body or, better, *movement of the air* is a prime necessity (see p. 198).

3. Ventilation (Latin *ventus*, "wind") is the name usually given to any circulation or movement of the air of rooms or buildings by which fresh, pure air, preferably from outdoors, is introduced and vitiated air is removed, the movement of the air being rapid enough to meet all the needs of the body, but not so rapid as to cause dangerous currents or drafts. This movement or circulation may be either intermittent and occasional, as when a window is opened for a little while and then shut; or more or less regular and constant, as in all efficient "systems" of ventilation or even in such primitive methods as that of the chimney above an open fire.

4. Natural ventilation. The walls of most houses are more or less porous and permeable for gases. Cracks and crevices around doors and windows also allow gases to leave and enter. In an experiment made by one of the authors four ordinary gas jets in a small room were left open (but not lighted) all night, and after the gas had poured in for eight hours it was found that the room contained only three per cent of gas, the remainder having escaped by *natural ventilation.* It is largely because of the cracks, crevices, and pores in the walls that human beings get on as well as they do in rooms and houses seemingly wholly unventilated. Wood, brick, stone, and plaster are more porous than glass, iron, or glazed brick, and dry walls more porous than those wet or damp. Painted and papered walls are less porous than those left bare, and accordingly the walls of summerhouses are often loosely made, preferably of wood stained rather than painted.

5. What we mean by good or bad, pure or impure, air. Air is not a chemical compound of fixed composition, but a mixture of gases containing, even when pure, varying amounts of nitrogen, oxygen, carbonic acid, ammonia, and water — this last in the form of invisible (aqueous) vapor. Moreover, the density of the air varies not only at different places but also at the same place at different times. Impure air contains all these gases and may contain, in addition, any other gas capable of mixing with them, such as hydrogen sulphide, carbonic oxide, marsh gas, etc. The terms "good" and "bad" air, "moist," "fine," "dry," "bracing," "muggy," "humid," "heavy," "foul," "fetid," "stagnant," "dead," "thick," or "lifeless" air, and all similar terms, are popular descriptions of atmospheric conditions real or imaginary, testifying to the wonderful variety of this part of the environment of mankind.

We may define "pure" air as any portion of the atmosphere free from noxious gases or vapors and from infectious microörganisms. Such air may, however, be unfit for breathing, as is the case with those higher portions of our atmospheric ocean into which aëronauts have sometimes ventured. At the height of four miles above the sea the air no doubt is very "pure," but yet too thin to support human life readily.

Air may be considered as polluted or "impure" when it contains noxious gases or floating particles in large numbers (as in smoke) or disease-producing germs.

6. The sources of discomfort and danger in air. We must be careful to discriminate between discomfort and danger in atmospheric conditions. Positive danger comes chiefly from deficiency of oxygen, excess of carbon dioxide, admixture of poisonous gases, or from infectious microörganisms. Aëronauts, explorers on high mountains, and persons living at great altitudes are apt to suffer from oxygen deficiency. Miners, charcoal burners, and well cleaners sometimes suffer from carbon-dioxide excess. Laborers in gas works and consumers of illuminating gas may be poisoned by carbon monoxide; and workers in sewers, by various gases, especially by illuminating gas which may have leaked in. Air may also contain, and thus convey, germs of infectious diseases.

On the other hand, air that is perfectly "pure" may be a source of great discomfort, simply because of its temperature or moisture, or its temperature and moisture taken together. The air in the "dog days" of August is no less pure than that of June or October, yet it is often oppressive because it is both too warm and too moist. It has been shown in Chapter XII how greatly the regulation of the temperature of the body depends upon the capacity of the atmosphere to take up moisture, and it is plain that any atmosphere saturated or nearly saturated with aqueous vapor must seriously interfere with the cooling of the body. A careful review of that chapter will greatly help the student to an understanding of the sources of discomfort in the atmosphere of houses or rooms.

A *shut* and *uninhabited room* often becomes "musty" or "damp" because of a want of circulation to remove air containing traces of odoriferous gases and excess of moisture — the former perhaps derived from carpets or furniture, the latter from the basement or cellar.

The air of an *inhabited room* may prove a source of discomfort to its inmates and therefore deserve to be called *bad* for any or all of the following reasons: (1) the air may be overheated or underheated; (2) it may contain an excess of moisture due either to its dampness of location or to the breath of its inmates; (3) it may be deficient in moisture and thus exert too strongly a drying effect upon the skin, eyes, or mucous membranes of mouth, nose, and throat; (4) it may be deficient in the movement necessary to renew promptly the air in immediate contact with the body; (5) it may contain odoriferous gases which cause discomfort.

What such rooms do not often suffer from is oxygen deficiency or carbon-dioxide excess, for experiments have proved that unless the oxygen falls below 12 per cent or the carbon dioxide rises above 3 per cent (conditions which are very rarely met with in ordinary human habitations), no marked discomfort ensues.

7. Ventilation replaces bad air with good air and causes aërial movement or circulation. It is now easy to see precisely how ventilation aids us in securing comfortable and agreeable atmospheric conditions. It removes bad air and supplies good (that is fresh) air and, by causing movement, favors evaporation from the skin and consequent cooling on muggy days. It is also easy to see why ventilation is at times ineffective. No system of ventilation can wholly overcome the mugginess of a close room in August, because the pure outer air is itself unpleasant and uncomfortable; but active ventilation, by producing a breeze, can do more than anything else to make the conditions tolerable.

8. Fans and fanning. It is an old point of dispute whether or not a person who fans himself grows cooler or warmer. However this may be, there can be no question that persons who use fans *feel* cooler, and there is no doubt that anyone fanned by another or by a breeze not only feels but actually is cooled thereby. The great and growing use of electric fans in hotels, houses, etc. testifies to the same fact.

9. A room may be well ventilated but oppressive from overheating. This fact, though perfectly obvious, and familiar to all who have been in well-ventilated boiler rooms or who have lived in the tropics, is too little attended to. Many public halls, Pullman and other railway cars, steamboats, and private houses, especially in the northern United States, are rendered almost intolerable and very unhygienic by simple overheating. Elderly people and infants require higher room temperatures than do active persons in youth and middle life, but in general any temperature above 70° F. must be regarded as excessive, and 65° to 68° F. is a better temperature (see Chap. XII). Housekeepers, at least in the northern United States, would do well to try to keep the mercury in their houses between these lower limits. When the outdoor air is cold and moist a somewhat higher temperature is often required than when it is dry.

10. A room may be comfortable in temperature but defective in ventilation. This fact is less obvious than that just considered, but it is nevertheless true. It may be because of excessive moisture, or because of odors, or for other reasons; but those entering such rooms from out of doors are often able to remark and deplore the fact. It is perhaps oftenest exemplified in warm countries or in warm seasons when people close and darken rooms to "keep out the heat."

This climatic condition presents a very real choice of evils. If the room is closed it becomes close; but this may be measurably relieved by the use of electric fans. On the other hand, if hot air of high humidity is admitted in large quantities from without, the temperature of the room is raised; inasmuch, however, as it does not usually reach that of the outside air, the *relative humidity*[1] is increased, much to the

[1] By relative humidity we mean the amount of water vapor the atmosphere contains expressed in percentage of the maximum amount which air can contain at that temperature. For example, air at 80° F. will hold only 70 per cent as much water vapor as air at 98° F. If, therefore, air at 98° which has a relative humidity of 70 per cent, and hence is capable of taking up considerable additional water vapor, is brought into a room and thereby cooled to 80°, it will be virtually saturated. Into such air perspiration cannot evaporate.

discomfort of the occupants of the room. Perhaps the lesser of the two evils is to air the rooms well in the early morning, then close or almost close the windows as the day grows warmer and relieve the atmospheric stagnation by the use of electric fans. As the evening grows cooler windows should again be opened. When fans are not available the lesser of the two evils is to leave the windows open, especially when a breeze can thereby be secured.

11. Some practical hints about the ventilation of rooms. We have already referred to the great value of chimneys and open fireplaces as ventilators and to the "natural" ventilation by porous walls and by cracks above and below doors and windows. The simplest and most usual artificial method of ventilation is the opening more or less widely of windows or doors, and this is a means which should never be disregarded. The great drawback associated with it is the fact that uncomfortable and frequently unwholesome drafts are likely to ensue. It should be remembered, however, that the existence of a decided draft is usually an indication that the amount of ventilation is greater than is necessary. When the wind is blowing against a window, it is enough to open it an inch or less; if the wind is blowing very hard, the natural ventilation may be sufficient. Moreover, the amount of natural ventilation secured depends quite as much on the ease of egress as of ingress of air. It often happens that if the window be closed or very slightly opened on the windward side of the house, enough natural ventilation will be secured by opening other windows on the side away from the wind.

It is often possible, especially in warm or temperate weather, to secure satisfactory ventilation by opening windows both at the top and the bottom, the warm air passing out above, while cooler, fresh air comes in below. This is not advisable, however, when the temperature of the incoming air is too low, since the air then sinks at once to the floor and chills the feet. Another good plan is to raise the lower sash three or four inches and place under it a board made to fit the space. Air now enters between the sashes, and the air being directed upward, the occupants of the room are protected from drafts. Where electricity is available an electric fan placed in one of the upper sashes is frequently very effective in hastening the removal of vitiated air. Fans for this purpose are now readily obtainable and have proved to be serviceable.

In winter fresh air and good ventilation cost something, as the air must be heated; but it is poor economy to use stagnant air for the sake of saving fuel. The keen edge of capacity for good work is dulled by bad air, the vital resistance is lowered, and the susceptibility to disease increased. On the other hand, there is such a thing as too much ventilation, for if it causes harmful drafts or leads to actual chilling of the body, it may do almost as much harm as too little ventilation. Here again each individual must study and determine his own needs.

The hot-air furnace is capable of supplying fresh air in abundance and, if the air be not overheated or overdried, gives an admirable method of heating and ventilation combined in a single device, — the jacketed stove, — provided always that the air supplied to its heating chamber is unobjectionable.

12. Mechanical systems of ventilation. Buildings larger than dwelling houses, such as large schoolhouses or public halls, are (or should be) ventilated by some mechanical system. These are of two principal types, known as the *vacuum* and the *plenum* systems. In the former an attempt is made to effect good ventilation by sucking out the air from the building by an exhaust fan or blower attached to one main pipe, or duct, to which are led tributary ducts connected with the various rooms. To supply the air thus removed, fresh air is supposed to make its way in either by natural ventilation (p. 447) or through inlet ducts specially provided, in either case being pressed in by the outer atmospheric pressure. In the plenum system this arrangement is reversed and air, previously warmed if need be, is driven by a fan into a main duct or space, from which smaller ducts carry it to the various rooms, circulation being favored by outlet ducts, through which the air flows away. Sometimes an effective combination of the two systems is used, in which case the air is not only pumped in but also, at the same time, sucked out.

In favor of the plenum system it may be said that instead of currents of (often) cold air pressing in by the paths of natural ventilation about doors, windows, etc., the direction of the aërial current at these places is reversed, owing to the pressure to which the air is subjected, so that it is more often possible to sit very near such windows and doors.

The combination of the two systems offers many practical advantages, but is obviously relatively costly. It is sometimes forgotten that air, quite as truly as water, possesses inertia and moves along paths of least resistance; but experience has shown that in order to govern the direction of flow of the aërial stream it is often necessary as well as advisable to control the outgo as well as the income of air.

CHAPTER XXX

THE WATER SUPPLY, PLUMBING, AND DRAINAGE OF THE HOUSE. GARBAGE AND RUBBISH

1. Water supply. The water supply of the house should be first *pure*, and second, *abundant*. No exact figures can be given as to the amount required, but for kitchen and laundry use, bathing, and good drainage, it is safe to say that thirty gallons per day per capita are ample. An ordinary barrel holds this amount. Most families get on with very much less; but for the greatest convenience and cleanliness some such quantity, if not absolutely needed, can be used to advantage, and no domestic supply is a greater luxury than abundant water.

The purity of the domestic water supply should be above suspicion. In a following chapter we shall emphasize (Chap. XXXIV) the requirements as to purity of a proper public water supply from which the domestic supply may be drawn; but we may here consider briefly those private supplies, such as wells, springs, and brooks, from which many houses, especially in the country, must obtain their water. It is worth remembering that all water in or upon the earth was originally rain water (that is, distilled water from the atmosphere). This, when it flows over the surface of the earth or percolates through the ground, is known later as *surface water* or *ground water*. Streams, such as brooks, creeks, and rivers, are composed largely, but by no means wholly, of surface water; deep wells, dug or driven, and many springs contain a mixture of surface and ground waters. Surface waters are particularly exposed to pollution by dirt and filth from roads, manured fields, and the surface of the ground generally. Ground waters, on the other hand, although subject to pollution by percolating through buried filth and by surface waters mingling with them through cracks or fissures in the earth, are, in general, subject to great *purification by filtration* during their percolation through earth, which often acts as a porous filter (Fig. 127).

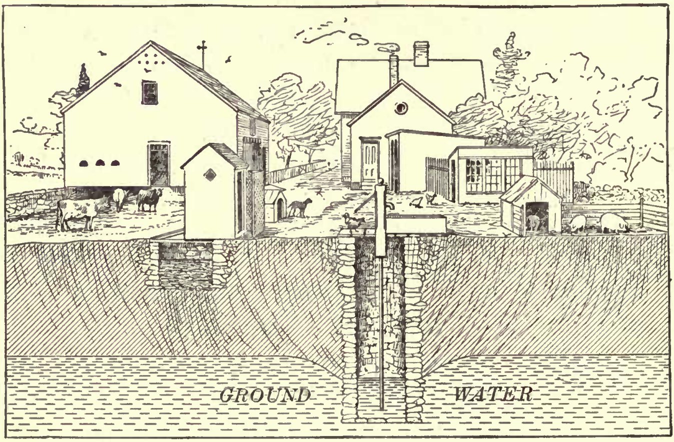


FIG. 127. A domestic well badly situated in a farmyard

Observe that the water which it yields is partly drainage from the barnyard, privy, pigpen, etc. It is also exposed to pollution at the top

2. Domestic wells. The well of water has an ancient reputation and has long been celebrated in song and story. As a supply more or less public it has often served as a meeting place and a social center and has frequently been ornamented with decorated curbs or covers testifying to popular esteem. Until 1854 the common well was, with rare exceptions, regarded as a perfectly safe and satisfactory method of securing water for public as well as private water supplies; but in that year all wells began to be regarded with suspicion because of a disastrous outbreak of Asiatic cholera in London, which was conclusively traced to a polluted public well on Broad Street in that city. It was found on investigation that a privy vault, probably infected by the discharges of a cholera patient, had leaked directly into the well; and immediately all wells, especially those near any source of pollution, fell under suspicion.

The truth, in brief, appears to be that many wells are absolutely innocent of all contamination and yield excellent water. Some wells undoubtedly contain water originally impure, but purified by filtration because it has come a long distance through the soil before reaching the well. Others, however, are in more direct connection with cesspools, privy vaults, barnyards, stables, or similar objectionable and perhaps dangerous sources, and are utterly unfit to serve as water supplies for domestic uses. Still others, though receiving good water from the earth about them, yield bad water because objectionable matters find their way in at the top. Poultry should be prevented from walking over loose planking which only partially covers the well, and farmers whose boots have become fouled by walking in barnyards or on fields heavily manured with stable manure should be careful to avoid doing likewise. The danger of even worse contamination of wells from manure or other surface dirt washed in at the top during heavy rains is also very great (Figs. 127 and 128).

3. **Springs** are usually sources of pure water, but a spring in a barnyard or a cemetery would be plainly objectionable, and care should always be taken to ask whence comes the water which the spring yields. Springs often occur on hillsides; in such cases they should be protected from the possibility of surface pollution, while sources of pollution of any sort higher up the hill should not be tolerated, since from these the spring may become contaminated.

4. **Cisterns of rain water** are often used for domestic supply in country houses and in some places, such as New Orleans and the Bermuda Islands, where wells are not available.

There is no objection to this practice, which should secure a pure and very soft water, provided the roofs, cisterns, reservoirs, and other receptacles employed in collection or storage of the water are clean and suitable. Painted roofs, and pipes, roofs, or reservoirs containing any exposed metallic copper or lead, should be avoided, since rain water may attack these metals, forming with them soluble and poisonous salts.

After a long dry period in summer, roofs are often dusty and dirty, and the first washings of dirty roofs should be allowed to go to waste. Rain water collected in winter or spring and subjected to long storage is probably the purest and most desirable cistern water.

5. Streams, such as brooks and creeks, are sometimes used as sources of private domestic water supply, and if the places which they drain are wooded and entirely uninhabited, that is, not manured in tillage or pasturage, the surface water which they yield may answer fairly well for house use. But even at its best such water is exposed to pollution by wild animals and by passing tramps, fishermen, or gunners, and a carefully protected well or spring is, as a rule, a safer supply. Well water is often more palatable, especially in summer, but is sometimes very *hard*. For washing, surface or rain water is generally softer and of course unobjectionable.

6. Hard waters and soft. Rain water contains few or no salts in solution and is therefore called *soft* water. Many surface waters and some well and spring waters are also soft. All such waters readily dissolve soap, and because soapy waters are sticky and easily form air bubbles, a "lather" or "soapsuds" is easily made in soft waters with very little soap.

Other waters, and especially ground waters, contain salts in solution, some of which, notably those of calcium and magnesium, form precipitates with soap, thus removing it from the water in which it is placed. Such waters, therefore, require more soap to make them soapy, lathery, or sudsy, and are known as *hard* waters, because they feel less bland or soft to the skin.

In some parts of the United States the well waters (and sometimes even the surface waters) are so hard as to be almost or quite useless for washing, and even for drinking. It has never been shown that moderately hard waters are necessarily any more harmful for drinking than soft waters. Persons used to either kind are apt to suffer temporary disturbances, such as diarrhea, when they change suddenly from one to the other; but otherwise no great or permanent harm ordinarily happens. If, however, a drinking water is very hard and heavily charged with mineral salts so that it becomes essentially a mineral water, it may be unfit for regular use.

7. **House filters** for water are not needed if the water supply is pure and colorless, but in many places this is not the case. If the water supply is impure it should either be carefully filtered by a germ-proof filter (several kinds being on the market, but all of them costly) or else boiled for a few minutes and cooled before it is used for drinking. If the water is pure but colored or turbid, it may be made bright and attractive by filtering through a charcoal filter; but this also, if durable and effective, is sometimes costly.

8. **The ice supply** of the house is one of the greatest of modern conveniences. Ice in summer was formerly a luxury, but in northern latitudes it is now generally harvested in winter and stored for the following summer. In warmer climates the so-called artificial or manufactured ice brings the same luxury within reach of persons of moderate means. Provided the water from which it is made is pure, manufactured ice is as wholesome as the best natural ice. The economical value of ice in preserving foods is very great, as is also its sanitary importance in hindering harmful decomposition and decay (for example, in milk).

Ice water, so generally used as a beverage in America, is probably harmless enough when not drunk in too large quantities or too rapidly; although, as a matter of fact, thirst is normally slaked by cool water more effectively than by very cold water. The ice added to drinking water should be pure; that is, ice obtained from ponds, streams, or other waters unfit to serve as sources of domestic water supply should never be used in water intended for drinking purposes, and all ice should be carefully washed before being so used.

9. The plumbing of the house. Almost all houses have a sink of some sort; from this there runs a drain-pipe, which should be tight, and large enough to carry off readily the drainage from the sink. Many houses have in addition more or less complex systems of water supply and drainage requiring piping and plumbing.

The *plumbing for water* calls for brief comment only. Lead service-pipes should, as a rule, be avoided, for experience has shown that if the water passing through lead pipes happens to contain an excess of free carbon dioxide, this may attack the lead and form with it a soluble bicarbonate, which is a dangerous poison. In Massachusetts there have been several epidemics of lead poisoning due to this cause.

The *plumbing for drainage* should aim to provide against escape or leakage of both liquids and gases. As drain-pipes are not usually filled with liquids or gases under pressure, leaky joints and even small holes may, and often do, occur without detection. If under such circumstances any stoppage happens, pressure may arise and the liquid or gaseous contents escape. It was formerly believed that great danger existed in defective plumbing owing to the escape of sewer gas or gases by leakage and, particularly, from the pressing backward, or "rising," of sewer gas into bathrooms, or sleeping rooms provided with set bowls, etc. The present view is that while such gases may and probably sometimes do escape into houses, they are usually greatly diluted before they are breathed and, at the worst, are much less harmful than was formerly supposed. They are, nevertheless, highly objectionable, and it is likely that they occasionally produce serious poisoning. If breathed for a long time, even in small amounts, they probably lower vital resistance and increase susceptibility to infectious disease, and are thus not merely objectionable but also dangerous.

Pains should be taken to ventilate thoroughly all places, such as sleeping rooms, bathrooms, and water closets, into which sewer gases may find their way, and it is advisable and customary to seal up the various drain-pipes by water seals, or *traps*. If, in addition, the main drain-pipes are provided with vents to allow the escape of any gases accumulated in the pipes, the essentials of sanitary plumbing have been secured. Good workmanship is, however, indispensable in all water- and drain-pipes, as well as in all gas-pipes in the house, to prevent serious damage from breaks or leaks.

The main drain-pipe in the house is called the *soil-pipe*. This usually empties into an underground drain or *sewer* outside the house, which discharges its contents — now known as *sewage* — into a cesspool or a stream, or upon a sand bed, a sewage filter, a cultivated field, or some other place of sewage disposal.

10. Drainage and the disposal of household wastes. The consumption of the solid and liquid supplies of the house — water, ice, coal, food, etc. — is accompanied by the formation of various wastes which for sanitary as well as æsthetic reasons must be promptly got rid of. Waste water and melted ice necessitate drainage; the dust and ashes of fuel remain to be disposed of, and from food, putrescible remnants, known as garbage. Dirt, bottles, papers, boxes, tin cans, old clothes, worn-out mattresses, broken furniture, crockery, and glass must also be removed. Among all the wastes of the house, however, the discharges of human bodies are of the first importance not only because of their putrescible and disagreeable character but also because they frequently contain the germs of dangerous diseases.

Drainage is often necessary for a house merely to carry off rain water from the roofs and to keep the cellar dry. It is very important to remove all surplus water from the house and its vicinity in order to prevent dampness — this being one of the most unfavorable conditions in the environment of mankind.

If the drains of houses or lands carry water only, they keep the name of *drains*, and the water in them is called *drainage*; but if such drains carry household wastes and, especially, human or animal excreta, they are more often called *sewers*, their contents being known as *sewage*. The process or act of removing sewage from a house or a city and the systems of sewers are both known as *sewerage*, although this same term is sometimes popularly applied to the sewage itself.

11. The disposal of drainage and sewage. Cellar drains and drains for the removal of roof water usually discharge, especially in the country, upon the surface of the ground at some distance from the house and give little trouble; but sink drains, since they contain dish washings, soapsuds, and the liquid wastes of the kitchen, are apt to become choked with grease. Grease is dissolved by alkalies, and common lye (potash) allowed to dissolve and flow down the sink waste-pipe will often remove greasy obstructions and give at least temporary relief. The final disposal of sink water, however, is more difficult, and a greasy, slimy, malodorous, and unsightly channel or area behind a country house too often tells of trouble. The only complete remedy is a large waste-pipe, as straight as possible, going to an equally large or larger (underground) drain, which ends in a covered pit or tank placed in porous or gravelly soil. This pit must be cleaned out from time to time, and if no open porous soil is available a tight tank or pit must be used and frequently emptied.

Sewage disposal is a more difficult matter, for sewage contains not only the sink wastes just mentioned but also washings from the human body, human excreta, and other putrescible matters, all in comparatively large volume. We shall discuss later (Chap. XXXIV) the problem of the disposal of the mixed sewage of numerous houses combined into communities and therefore at this point need consider only the disposal of the sewage of separate houses, such as country

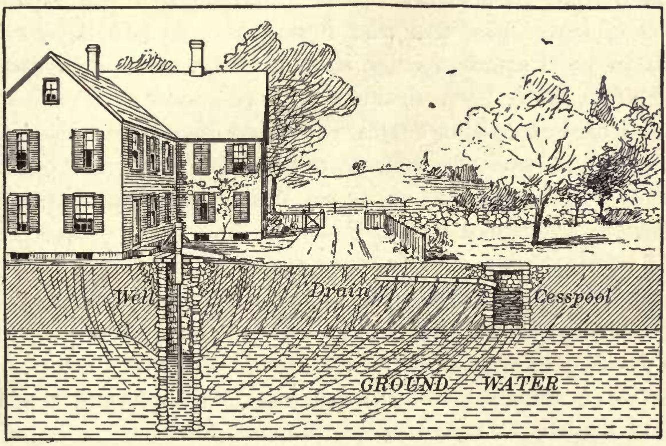


FIG. 128. Disposal of household sewage by means of a cesspool

Observe that the loosely laid drain-pipe, or sewer, allows some sewage to leach away before reaching the cesspool. If no well were near, this would be a distinct advantage

homes or farmhouses. If these are so placed as to be readily drained or *sewered* into the sea or into some large lake or stream nowhere used for drinking purposes, the solution is simple. If not, the cesspool and disposal upon land, as described in the following paragraphs, are among the best expedients.

12. The cesspool is a receptacle or tank in the earth, at some distance from the house, — not less than one hundred feet away, and the farther off the better, — into which sewage is conveyed by a drain or sewer directly connected with the soil-pipe of the house. The cesspool may be either water-tight to prevent leakage or loosely built to favor it. A common construction is one in which the cesspool is water-tight and has an outlet pipe just below the surface. This outlet pipe may run into a drain, loosely laid to facilitate leakage from its joints and thereby the escape of liquid sewage into the earth.

It was formerly held that the cesspool was a sanitary abomination, that it favored putrefaction and the development of sewer gas, and that it ought always to be avoided if possible. Experience has shown, however, that thousands of houses have been drained into cesspools not only conveniently but without the slightest discoverable sanitary injury; and sanitary science now recognizes in the *septic tank* (a special form of cesspool) a useful and popular means of sewage disposal.

13. Irrigation and subsurface disposal of sewage. Another method often successful, especially in soil which is open and porous, that is, in sandy soil, is that of simply discharging the sewage upon the surface of land set apart for the purpose at a distance from the house. This method may be recommended in many cases, but is often less satisfactory than the use of a well-regulated cesspool. A modification of it, in which the sewage is distributed *under*, instead of *upon*, the surface by means of a system of branching pipes loosely laid, is frequently preferable, even in the same porous or sandy soil; but neither of these methods is to be recommended as compared with the cesspool, if the soil is impervious or clayey.

14. The domestic privy. In the absence of a water supply sufficient for drainage, a well-kept privy is a necessary sanitary adjunct of the house. The two sanitary considerations of prime importance are the prevention (1) of access of flies and (2) of soil pollution. Access of flies is readily prevented by well-made walls, roof, doors, etc. and by thoroughly screening all window openings. The use of flytraps on the premises contributes even more effectively to this result. The avoidance of soil pollution is a most important sanitary measure, especially in warmer climates where hookworm abounds (p. 509). It is readily accomplished by placing receptacles (for example, 6 to 8 gallon galvanized-iron buckets) beneath the seats. The top of the bucket should fit as closely under the seat as possible, and the bucket should rest on a well-made stand or flooring covered with tin or galvanized iron. Painting the inside of the buckets and the floor on which they rest with asphalt paint protects from rusting. To prevent access of flies the entire space under the seat around the buckets should be closed by a tightly fitting door opening outwards, through which the buckets may from time to time be removed and their contents buried in the earth. Disagreeable smells are lessened by throwing in dry earth or ashes from time to time.

15. The care and disposal of garbage is a matter of much importance both to the housekeeper and to the community. Garbage consists chiefly of the more solid refuse from the kitchen and, since it is composed of the remnants of food, it is highly putrescible. On the farm, garbage may be fed to swine, and in many towns and cities it is collected by farmers and used to maintain large (and often offensive) piggeries in or near a city or town. More rarely garbage is fed to milch cows, the milk from such cows being known as *swill milk*; but this use of garbage is rightly forbidden by boards of health.

In the house, garbage is simply a nuisance, to be got rid of as quickly and as completely as possible. It should be either burned (in which case disagreeable odors are often produced) or kept as short a time as possible in a *clean* receptacle in or near the kitchen. The garbage receptacle is usually the dirtiest and foulest-smelling household utensil. Nothing about the house requires more careful attention.

The receptacle itself should be of *metal* rather than wood; it should be no larger than is necessary, because a small can is easier than a large one to keep clean; it should have a tight-fitting cover to prevent access of flies; and it should be kept where dogs and cats cannot overturn or open it. Above all, it should be frequently emptied and cleaned.

16. The disposal of ashes, dirt, and refuse is perhaps as much a question of good taste as of sanitation. Nothing is more unsightly than a dump, especially if its papers, boxes, and other combustible materials are set on fire, as often happens, and left to smolder. In towns and cities ashes and rubbish (as well as garbage) are usually removed periodically by public carts, but isolated householders must ordinarily look after their refuse disposal themselves; and of all methods, burial in pits, when possible, is the least objectionable. For garbage, especially, when a piggery is undesirable and cremation not possible, burial in sandy land at a distance from the house has much to recommend it.

PUBLIC HYGIENE AND SANITATION

CHAPTER XXXI

PUBLIC HEALTH. COMMUNICABLE AND NON-COMMUNICABLE DISEASES. MICROBES

1. The public health. The environment of man consists of two principal and very different parts: one near and chiefly personal, domestic, or *private*, including his clothing, house, family, and estate; the other more remote, impersonal, and *public*, including his neighborhood, village, town or city, state, and country.

In sparsely settled districts little attention is paid to any health beyond that of the person or the family; and the family, as we have shown, is really a small and private community, but in thickly settled regions, such as cities and towns, conditions and problems arise involving numbers of families, and *public* hygiene and sanitation become necessities. In the country each family generally has its own private water supply, milk supply, food supply, and drains, but in cities and towns mutual convenience, economy, and safety require public supplies and public drains. Instead of private roads we find public streets; instead of private estates, public parks. Public gardens and public markets furnish flowers and vegetables; public conveyances, such as cars, steamboats, and carriages, serve public needs; public institutions arise, such as hospitals, schools, almshouses, and jails; and public buildings, such as halls, hotels, churches, schoolhouses, shops, factories, stores.

In all such cases numbers, groups, or masses of individual families — called collectively *the people* or *the public* — are at times and as a whole exposed to unfavorable conditions, such as a general want of muscular exercise, lack of sleep, a too sedentary life, and overwork; or to germs of infectious and contagious diseases in public supplies of water, milk, etc.; or to foul air, overheating, defective lighting, gas poisoning, noise, dust, smoke, or impure food; some of which conditions are chiefly *personal*, affecting more or less directly the bodies of the people, while others are more remote, or *environmental*.

By the PUBLIC HEALTH we mean the health of the public, that is, of the people as a whole; and the health of the public depends — just as the health of the individuals who compose that public depends — on a great variety of conditions, some of which, as just stated, are chiefly internal, or in intimate relation with the persons of the people, and may conveniently be called *hygienic*; while others are chiefly external, or at least not in intimate relation with the persons of the people, but rather in their environment, and may be described as *sanitary*.

The applications of the various branches of science, such as physiology, chemistry, bacteriology, vital statistics, climatology, medicine, engineering, etc. to the control of these various hygienic and sanitary conditions, and thereby to the protection and promotion of the public health, constitute *the science of public health*; and of this, as indicated in the last paragraph, there are two grand divisions, namely, *hygiene* and *sanitation*.

2. Public-health rules and regulations. For the regulation and control of those conditions which are personal and domestic we must look, even in large communities, chiefly to individuals and families; but even if individuals and families always obeyed the laws of personal hygiene and domestic sanitation, the protection of the public health would still require special supervision and control of public supplies, public drains, public vehicles, public institutions, and the like, because these things are outside and beyond the control of private individuals or families and stand in a class by themselves. In point of fact, however, private persons and families are often negligent in matters of this kind, inflicting damage upon their neighbors by maintaining *nuisances* of one kind or another, or else by their carelessness in respect to filth, or in respect to the spread of infectious or contagious diseases. Hence it has come to pass that sanitary and hygienic rules and regulations have been adopted by the citizens of most civilized communities for mutual benefit.

3. Public-health authorities. For the enforcement of these rules and regulations (*sanitary laws*) special public officials are usually elected or appointed, such as boards of health, health officers, city physicians, sanitary inspectors, medical inspectors, quarantine officers, school nurses, sanitary police, vaccinating physicians, etc. By common consent of the majority of the citizens these officers are authorized and required under the laws to prepare, publish, and enforce needful sanitary rules and regulations for the protection and promotion of the public health.

4. Public-health problems. In this and the following chapters we can touch upon only a few of those more elementary and important problems of the public health of which every educated citizen should have some knowledge. Such problems are almost all fundamentally concerned with the control of communicable diseases, to the nature of which we shall therefore at once turn our attention.

Much of what follows was formerly the exclusive possession of the medical profession and has only recently become a part of the common knowledge of mankind. Much of it also is comparatively new and among the best fruits of the splendid advances of the last half century in the sciences of pathology, hygiene, and sanitation.

5. Plagues, pestilences, and epidemics are the most striking examples of influences affecting both personal and public health. Only wars, riots, and great conflagrations are capable of throwing communities into such terror as has often been caused by plagues or pestilences of some swiftly fatal disease. Such was the plague in London described by Defoe in his *Journal of the Plague Year*, a story which has been well called "that truest of all fictions." History is full of similar instances. Even as late as 1892 the rich and powerful city of Hamburg, Germany, was terrorized by a severe epidemic of Asiatic cholera due to a polluted public-water supply, while still more recently the great city of New York and a large area of adjacent territory have been stirred by the plague of infantile paralysis.

Plagues and pestilences are simply older names for great *epidemics* of much-dreaded diseases, such as smallpox, yellow fever, Asiatic cholera, or the bubonic plague, and the pesthouse, which formerly existed in many towns and cities, was a remote and isolated shelter, or primitive hospital, often of the crudest and poorest kind, to which the victims of pestilence were taken (or driven) by a frightened public. The true sources of epidemics, plagues, and pestilences have only recently become known. Savages often attribute these to supernatural causes, such as evil spirits or demons, and even for civilized people pestilences were until recently mysterious in origin and incomprehensible in behavior. It is now known, however, that such outbreaks are simply extensive epidemics of contagious (that is, communicable) diseases, which may often be controlled and even prevented; but *in order that control or prevention shall be effective, the intelligent coöperation of all good citizens is essential.* It is one of our first duties to acquaint ourselves with the nature and the methods of prevention of contagious and infectious diseases, and thus at the same time of plagues, pestilences, and epidemics.

6. What are infectious and contagious diseases? The discoveries of Pasteur, Koch, and their successors in the last half of the nineteenth century have brought to light the remarkable fact that those "fevers" — typhoid fever, malarial fever (malaria), diphtheria, smallpox, cholera, tuberculosis, etc., and probably also measles, chicken pox, scarlet fever, and many "colds" — which attack apparently healthy persons and cause a severe but brief sickness that seems to run its course and then cease are due to invasions of the body by *microparasites*[1] called *microbes.* Each of these contagious or infectious diseases has its own special microbe to which it owes its origin; and it is customary to speak of the microbes of diphtheria, of typhoid fever, of the bubonic plague, of Asiatic cholera, etc. as the cause of these diseases. Although in some contagious and infectious diseases the microbe has not yet been discovered, all these diseases are nevertheless so much alike, and causative microbes have been found in so many cases, that all are believed to have a similar *microbic origin.*

The view or theory just outlined is known as the *germ theory* of infectious and contagious diseases, and the causative microbes are known as *disease germs.* It is easy, on this theory, to see why these diseases are "catching." It is, of course, not the disease but the parasitic microbes which can be "caught" or "taken," as fleas can be "taken" from a

[1] **Microparasites.** A *parasite* is a plant or animal which feeds upon another plant or animal (called its *host*) and renders it no services in return. Some parasites, like fleas, lice, the pork worm (trichina) and ringworm, are visible or almost visible to the naked eye; but many others are invisible and may be called *microparasites.* Of these the most important belong among the *microbes*; but as the microbes form an enormous group of plants and animals, most of which are in no way parasitic or harmful to mankind, but on the contrary are highly useful, we must be careful not to regard as parasites more than a very few of the microbes. Those that do not lead a parasitic life are usually *scavengers* and lead a *saprophytic* life; that is, they feed upon dead organic matters, often helping greatly to clean and to keep clean the surface of the earth.

dog, or bedbugs carried from place to place in bedding or clothing, or lice "caught" by children from lousy playmates. It is easy also to understand how destructive epidemics, plagues, and pestilences can occur if public food supplies, water supplies, milk supplies, carriages, steamers, cars, or other conveyances have become infected with dangerous microbes or disease germs.

An *infectious disease* is one in which the disease germs infect (that is, invade) the body from without. Such are diphtheria, typhoid fever, tuberculosis, trichinosis, scarlet fever, smallpox, measles, chicken pox, and all the more common "fevers." Among these some are ordinarily conveyed quite directly by contact from person to person, and to such infectious diseases the term "contagious" is often applied. Formerly a sharp line was drawn between infection and contagion, but to-day it is recognized that no such line exists. Typhoid fever, for example, is still mistakenly said to be "infectious but not contagious." If by this is meant that it is not as often spread through the air or by mere contact as are smallpox and some other diseases, that may be true; but if the saying means that it cannot be transmitted by mere contact with the patient or his excreta, then it is false. It would be better to drop altogether the term "contagious" and to use in its place the term "communicable."

7. Communicable and non-communicable diseases. From this point of view all diseases may be arranged in two grand divisions — communicable and non-communicable. Strictly speaking, of course, no disease is itself communicable. Disease is a condition of the body and manifests itself by a complex of symptoms, such as the fever, the thirst, the stupor, the delirium of typhoid fever. These bodily conditions do not pass over as such from A to B. It is only the causative agent — microbe or other parasite — which is communicable. In the preceding section we have named some of the commonest of the communicable diseases, and in the next chapter the prevention of some of these will be dwelt upon. Meantime we may turn to the other grand division — the non-communicable diseases.

Of the non-communicable diseases good examples are old age ("the one incurable disease"), cataract of the eyes, presbyopia (p. 249), diabetes, arterial sclerosis, valvular heart disease, and Bright's disease. All of these, so far as we know, are strictly personal, individual, and non-transmissible. They never break out in epidemic form, or "run through" a community, as do such diseases as measles or scarlet fever or tuberculosis, apparently because they are not due to microbic or other parasites, but to some defect, inherent or acquired, in the construction or to some error in the operation of the bodily mechanism. Old age, for example, is clearly not due to any germ or parasite but to gradual changes in the body which bring it about in rabbits and guinea pigs in four or five years; in sheep, cats, and dogs in a dozen years or less; in horses in twenty years or thereabouts; in mankind in "threescore years and ten"; in elephants in one hundred years; and in some trees only after the lapse of centuries. The causes of most of the non-communicable diseases are not well understood except in the case of those which, like certain diseases of the heart and other organs, are plainly due to congenital structural defects; or those due to bad management of the body, such as wrong feeding or exposure to damaging conditions, like those accompanying the so-called "occupational" diseases.

8. Defective diet and disease. In addition to the lowering of vital resistance by improper feeding, whereby the body succumbs to some communicable disease, it is now known that definite diseases are caused by the absence of certain elements from the food (see Part I, Chap. XIII). Scurvy, for example, formerly so common in prisons and on long voyages, is caused by the lack of something normally supplied by fresh vegetables or fruits and has been successfully combated by the use of limes or other fruits. Beriberi, a wasting disease which in the more severe forms involves degeneration of the nerve fibers, with consequent paralysis, has been shown to be due to the lack of materials (vitamines) found in the outer portion of cereal grains and removed in those milling processes which produce white flour or polished rice. Hence when one of these foods forms an unduly large proportion of the diet, as is the case with the rice diet of many of the poorer classes in the East, the deficiency in vitamines produces beriberi.

These vitamines or other essential elements of the food are also destroyed by heating canned foods to the temperatures used in the processes of sterilization (120° C. or higher). Hence to depend solely on canned foods is unwise or even dangerous. The prevention of diseases of this kind is a matter of the proper selection of food.

9. Occupation and disease. The prevention of diseases due to special occupations is in theory very easy, namely, by changing from a noxious to an innocuous occupation, although in practice this is often difficult to bring about. If a granite cutter, a miner, or a worker in phosphorus has grown old in the trade, it may be impossible for him to escape from an occupation which appears to be doing him harm. The "clergyman's sore throat" and the "housemaid's knee" may be curable for some only by avoidance of these occupations. The caisson disease ("the bends") can best be prevented by avoiding exposure to compressed air, and mountain sickness, due to the deficiency of oxygen at great altitudes, by avoiding mountain climbing, ballooning, aviation, etc.

On the other hand, many of these occupational diseases can and should be lessened or prevented by strict attention to personal hygiene on the part of the worker and to the sanitary conditions of the factory on the part of the employer. This important matter can often be best dealt with by legislation, as when Congress, by imposing a prohibitive tax on matches containing yellow phosphorus, forced the use of the harmless red phosphorus used in the safety match.

10. Microbes. Brief references have frequently been made on previous pages to microbes and their work, but we must now give them special consideration.

As the word implies, microbes (*micros*, "small"; *bios*, "life") are *little living things*, and they have been described

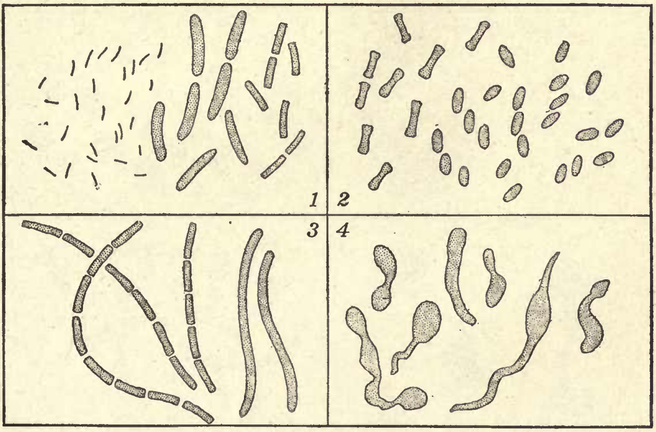


FIG. 129. Microbes (rod-shaped bacteria, or *bacilli*) (all very highly magnified) showing variations in size and form

1, bacilli, some very large and some very small; *2*, other forms of bacilli; *3*, bacilli forming threads or filaments; *4*, dead or dying bacilli (*involution forms*)

as "all forms of life, whether animal or vegetable, invisible or barely visible to the naked eye." It is customary to regard them as the smallest of all living things, and sometimes as identical with *bacteria*. All bacteria, however, are plants, so that a broader term, such as "germs," "microorganisms," or "microbes," is required if the lowest forms of animal life are also to be covered. In these pages we shall use the term "microbes" for *those forms of life, either plant or animal, which are invisible or barely visible to the* *naked eye and of interest or importance in physiology, hygiene, and sanitation.*

For our purposes microbes may be divided into *bacteria*, or vegetable microbes, and *protozoa*, or animal microbes. The *bacteria* are unicellular plants of the simplest structure and of three principal forms, namely, rods, berries (or balls), and spirals. The rods form the group *bacilli* (Fig. 129), the balls the *cocci* (pronounced *cock's eye*) (Fig. 130), and the

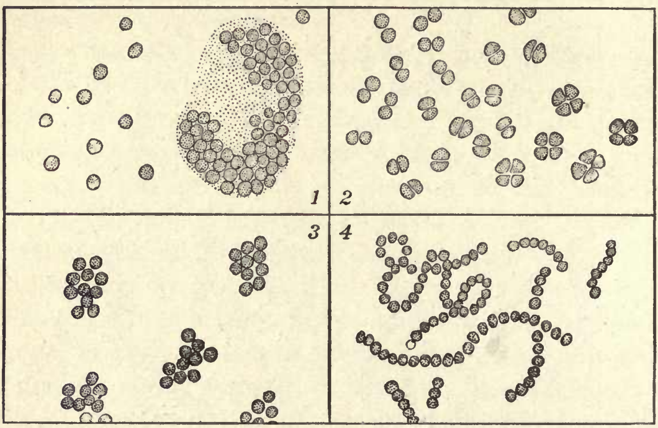


FIG. 130. Microbes (ball-shaped bacteria, or *cocci*, showing characteristic grouping of different forms) (all very highly magnified)

1, cocci single, and cocci united in a jelly mass known as *zoöglœa*; *2*, in twos and fours (*diplococci* and *tetrads*); *3*, in clusters (*staphylococci*); *4*, in chains or necklaces (*streptococci*)

spirals the *spirilla* (Fig. 131). Bacteria often grow and multiply (by simple cell division) very rapidly, and some are capable of producing within themselves smaller cells, called *spores*, which have thick walls and possess great powers of resistance (see Fig. 132).

The *protozoa* are unicellular animals, also of the simplest structure, and among them one group, the *sporozoa*, is of especial interest because it certainly includes the microbes of malaria and possibly those of smallpox and of scarlet fever (see Fig. 137).

Microbes are of interest and importance to the physiologist, hygienist, and sanitarian, first, because they are nature's scavengers, that is, removers of organic waste matters; second, because they are the ordinary agents of the decom-

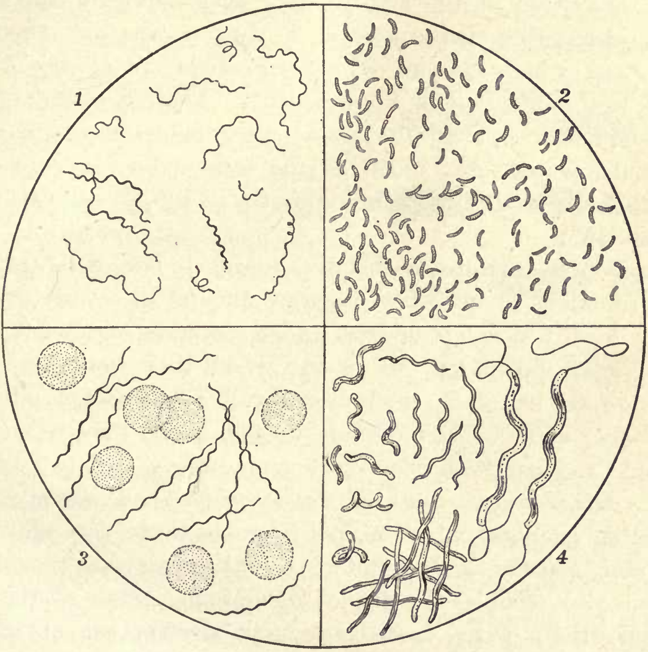


FIG. 131. Microbes (spiral or screw-shaped bacteria, or *spirilla*) (all very highly magnified)

1, spirilla from the human mouth; *2*, microbes of Asiatic cholera; *3*, spirilla of relapsing fever; *4*, large spirilla from ditch water

position, putrefaction, and decay of foods and other valuable organic matter; and third, because among them are found many microparasites, and especially those germs which cause communicable diseases, such as consumption, typhoid fever, diphtheria, and malaria.

1. *Microbes as scavengers.* Whenever the dead body of a plant or animal, or any part of it, is left upon the ground or in water or is buried in the earth, it soon crumbles or decays and disappears, turning, as we say, to dust and ashes. It was formerly universally believed that this change was a slow combustion or oxidation caused by the direct action of the oxygen of the atmosphere. It is now known, however, that this decomposition is due to the influence of microbes which abound in the upper layers of the earth and, to a less extent, in air and water. These decompose and subsequently oxidize the waste organic matters to carbon dioxide, water, etc., much as the muscle fiber decomposes and oxidizes the food brought to it by the blood (see Chap. IV).

It is now established that scavenging is one of the principal functions of microbes, for they abound in sewage, which they readily decompose and, under favorable circumstances, completely purify; in excrement, which they work over and change to harmless, inoffensive, and even useful mineral matters; and in many organic wastes, which they reduce to simple and harmless chemical compounds.

2. *Microbes as agents of decomposition and decay.* The peculiar property which makes microbes destroyers of waste organic matters, and therefore useful as scavengers, makes them also troublesome if not dangerous agents of the decomposition, decay, and consequent destruction of useful organic substances, such as foods. Milk, for example, may be spoiled by lactic-acid microbes, which feed upon its sugar and, by producing lactic acid in the course of their feeding, cause the milk to turn sour; but, on the other hand, this very change wrought by the microbes, though dreaded by the milkman, may be desired by the cheese-maker, in whose work the souring of the milk is necessary. The spoiling of meat, fish, fruit, and many other forms of food is due almost wholly to the vital activity of microbes, and we have to

invoke cold and heat for protection against their inroads. Cold, by chilling and benumbing microbes, checks their growth and multiplication; while heat, if sufficiently intense, destroys them altogether. Upon such use of cold is based the important art of refrigeration and cold storage; upon killing by heat, the great modern industry of canning.

Microbes have a wide and useful employment in the arts and industries, such as the souring of milk in cheese-making, the flavoring of cheese and butter, the preparation of hides for tanning, the ripening of manures, the fixation of free nitrogen in agriculture, and many other processes depending upon their vital activity. But, on the other hand, spoiled foods — especially meat, eggs, and fish — may be not only disagreeable but also dangerous, owing to the formation by microbes of poisonous by-products known as *ptomaines*, to whose agency have been attributed severe outbreaks of acute disease. Ptomaines are bodies of uncertain chemical composition which cause intense general prostration and sometimes death. It is a good rule to avoid carefully all meat or fish which is "tainted" or suspected of putrefactive decomposition.

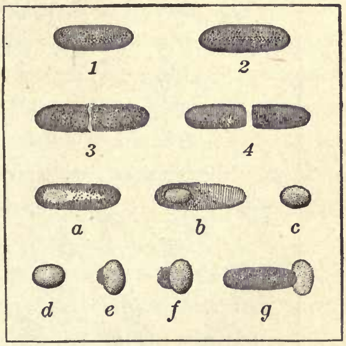


Fig. 132. Diagram of the growth, multiplication, and spore formation of a bacterial microbe

1–4, growth and multiplication by cell division (fission); *a–g*, formation, liberation, and germination of a spore

3. *Microbes as disease germs.* But it is as disease germs that microbes are of the greatest hygienic importance. Long before the nineteenth century it had been suspected that infectious and contagious diseases were caused by invisible germs of some kind, but it was not until the last half of that century that the responsibility for some of the worst

diseases that afflict the human race was clearly and specifically fastened upon certain microbes. For this great discovery we are indebted chiefly to Louis Pasteur, a French mineralogist and biologist, and Robert Koch, a German physician and bacteriologist. Thanks mainly to their genius and their patient labors, we now know that many of the infectious or communicable diseases of animals and plants are due

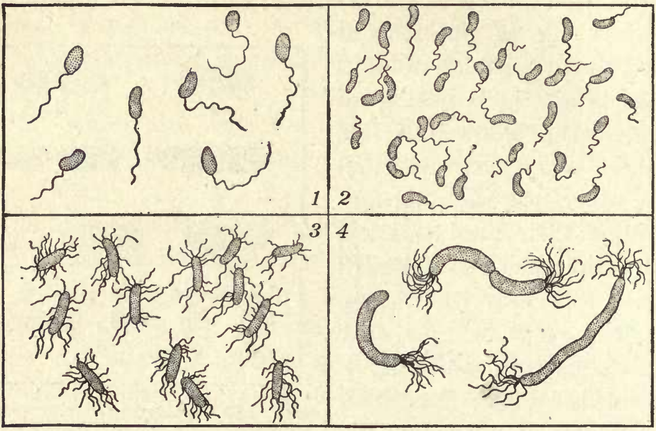


FIG. 133. Some motile bacterial microbes, showing flagella or cilia (all very highly magnified)

1, 4, large water bacteria; *2*, microbes of Asiatic cholera, known as the comma bacillus; *3*, microbes of typhoid fever

to the entrance into the living body of specific microbes which, growing in it or upon it, poison it and cause it to sicken or even to die.

But if infectious or communicable diseases are thus due to the attacks of microbes coming from the environment, we may hope to *prevent* these diseases, either by warding off the microbes or by making the body competent to resist or overcome them, or both; and it is one of the chief lessons of sanitation and hygiene to show how the warding off, the resistance, and the overcoming of infectious and contagious microbes may be most effectively accomplished.

11. The behavior and control of microbes. It must never be forgotten that microbes are living cells and, as such, subject to the laws which govern all living things. As a rule they work best at about the blood heat. They feed and grow and multiply by cell division. Like muscle fibers and gland cells they decompose their food materials and produce secretions and by-products, some of which may be harmless and some harmful. Microbes (or germs) are killed by strong acids, strong alkalies, and various other substances, which, for this reason, are called *germicides* or *disinfectants*. *Sterilization* is complete removal of microbic life. It may be effected by germicides or by intense heat, such as boiling or burning, or by various other means. *Pasteurization* is incomplete sterilization by heat, at a temperature sufficient to destroy most, but not all, germs. *Antiseptics* restrain or inhibit microbic activity, growth, and multiplication without necessarily destroying the germs themselves.

12. The prevention of microbic diseases. For the causation of any infectious or communicable disease two conditions must be fulfilled, namely, (1) *a specific disease germ*, microparasite, or microbe, and (2) *a person susceptible* to the disease in question. Without the microbe the disease cannot arise, no matter how favorable for it the condition of the person may be; and, on the other hand, the microbe is often powerless to produce the disease unless the condition of the person is favorable for its reception, life, and activity. This being the case, we obviously have at our command two principal lines of defense against the attacks of infectious and contagious disease; we must seek on the one hand to obtain (1) *control of disease-producing microbes*, and on the other to secure (2) *insusceptibility or resistance of the human mechanism* to their attacks.

Boards of health are constantly seeking to destroy or control dangerous microbes by requiring the reporting of all cases of infectious diseases, by isolation of such cases, by the placarding of houses, by disinfection, by the inspection of food and other materials, and in other ways. Cities are purifying their water supplies, their sewage, and their milk supplies, with a view to warding off the attacks of disease germs. Individuals also, if wise, will take all reasonable care to avoid exposure to infection by such germs, and will endeavor, as far as is practicable, to secure food and drink free from microparasites capable of causing disease.

To measures of this kind, devoted to the destruction or avoidance of the active agents of infectious disease, should be added efforts calculated to maintain personal resistance to their influence if, as sometimes happens in spite of all precautions, they find entrance into the body. The wise individual will study himself and learn from experience how to avoid colds and other slight ailments; he will regulate his diet and his exercise, his sleep and his bathing, his work and his play, in order to build up and maintain a strong constitution with which to meet any microbic invasions which may chance to occur. The wise and enlightened community will also provide parks and playgrounds, gymnasia and baths, and other means which will facilitate the cultivation of substantial health among its citizens, young and old.

CHAPTER XXXII

SOME PARASITIC DISEASES AND THEIR PREVENTION. VACCINATION AND ANTITOXIC SERUMS

1. Tuberculosis. One of the first diseases of which microbes were conclusively proved to be the parasites was tuberculosis, a disease to which more deaths are annually attributed than to any other. For the latter reason it has been called the "great white plague," and under the common name of "consumption" one form of it is only too familiar. The name "tuberculosis" was given to the disease because of certain characteristic cheesy nodules or tubercles (little tubers) found in the lungs and other tissues of persons affected with it, and until 1882 it was generally regarded as a constitutional disease, readily inherited and often "running in families." In that year, however, Koch announced the great discovery that in the tubercles could be found peculiar and apparently characteristic parasites belonging among the bacteria; also, that by special methods he had cultivated these microbes pure, or free from all others; and, finally, that with them he had inoculated healthy guinea pigs and actually *produced* tuberculosis in the infected animals.

Intense interest was everywhere felt in Koch's splendid discovery, which was quickly confirmed, and soon became an established and universally accepted fact. It is now known that tuberculosis is not ordinarily an inherited or constitutional, but an acquired, disease — infectious, communicable, and environmental in origin, and due to the ravages of a special microparasite, a bacterial microbe named *Bacillus tuberculosis.* It is true that the disease often runs in families, but communicable diseases frequently do this; and one reason why it affects some families so much more than others is believed to be simply that the individuals of some families are more susceptible to it, more adapted to its growth, than others, precisely as some soils are better suited than others for growing wheat or grass or corn.

2. How tuberculosis is spread. As this disease is caused by the invasion of a specific microbe, *it can only be caused*

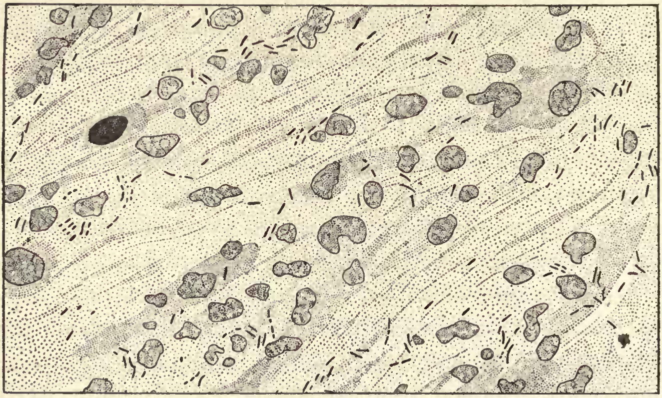


FIG. 134. The microbe of tuberculosis (*bacillus tuberculosis*) (very highly magnified)

A minute amount of the spit (*sputum*) of a consumptive has been spread out thin and photographed. The tubercle bacilli are the little sticks or small rods scattered all about among larger irregular epithelial cells, mucus, etc.

by the entrance of that microbe into susceptible bodies. Sanitarians generally believe that the principal ways in which tuberculosis is conveyed from one patient to another are the following: (1) by *personal contact* of tuberculous with nontuberculous persons, and especially by kissing. A consumptive mother or sister or friend fondling a baby and "smothering it with kisses" may thus transmit the germs of the disease to the child; (2) by *objects handled* or *mouthed* (such as food, forks, drinking cups, pencils, or towels) first by consumptives and then by susceptible non-consumptives; (3) by *dust* containing sputum expectorated upon streets or floors and then dried and carried in the air; (4) by *milk* or *meat* of tuberculous animals; and (5) by *the moisture of the breath* thrown off not as vapor but as fine droplets or spray, in coughing or even while talking. It is not possible to determine just what part any or all of these play in the dissemination of the disease. At one time it was thought that the principal vehicle of tuberculosis was the spit, or sputum, of tuberculous patients expectorated upon floors, sidewalks, or streets and afterwards dried, pulverized, and driven about as dust particles, which might readily find access to healthy throats and lungs. There is no doubt that the spit of consumptives may, and often does, contain the germs of the disease, and for this reason "spit cups" and destructible handkerchiefs (for example, of paper) should always be used by them; but further investigations have shown that drying and exposure to sunlight both tend to weaken and to destroy microbes, so that to-day, while dust is still regarded by all as a vehicle of considerable importance in the spread of tuberculosis, much more significance than formerly is attributed to other factors, especially to personal contact.

It is an open question how far milk is a carrier of tuberculosis. Cows undoubtedly often suffer from a form of the disease not readily distinguishable from that which occurs in man, and the frequency of tuberculosis in children certainly suggests that infected milk may have been the cause of it. On the other hand, it is far from certain that bovine tuberculosis is readily transferable to man; and at present, while it may be that milk is an important vehicle of the disease, the whole question is still debated. The same thing is true of meat from tuberculous animals, although in this case thorough cooking must destroy most, if not all, of the germs. The safest plan is to use for food no milk or meat which is in the least doubtful in quality, at least not without first subjecting it to thorough cooking. At present personal contact and the dissemination of the bacilli by means of finely divided droplets of mucus or moisture, as suggested above, are regarded as of special importance.

3. The prevention of tuberculosis. No successful steps have yet been taken toward the prevention of tuberculosis by vaccination or in any other way than by warding off the microbe and by helping the patient in his struggle with it by giving him good air, good food, rest, and all other favorable conditions which aid the body in resisting infection and the ravages of the disease.

It has been proposed to isolate cases of tuberculosis and in general to deal with them very much as the more contagious diseases are ordinarily dealt with. There is something to be said in favor of this plan, but the general opinion is that such isolation is a hardship to the patient and not often necessary for the safety of the community. Consumptives should, however, be expected and even required to be especially cleanly in their habits and to collect and destroy their sputum in cheap paper cups or in paper handkerchiefs, which can readily be burned. They should never spit upon floors or streets, or cough into the faces of friends or attendants, and they should wash their hands and mouths frequently and thoroughly.

Milk or meat derived from tuberculous animals should not be used without thorough cooking, and dust, which may contain germs of tuberculosis, should be kept down as far as possible both in houses and in streets. Above all, every means of direct conveyance of the fresh virulent microbes from persons having the disease to new victims should be carefully avoided. Some of these means are kissing and coughing, by which latter minute infectious particles may be thrown to a distance to be caught upon the face or hands of friends, or upon food, tableware, or linen. Any lack of absolute cleanliness in washing dishes, cups, spoons, napkins, etc. recently used by consumptives, is to be scrupulously avoided, and those who do the washing need to be on their guard against infection, by exercising extreme care and cleanliness.

There are many other forms of tuberculosis besides consumption, but this is the form of principal interest to students beginning the study of hygiene and sanitation.

4. Hygiene in the treatment of tuberculosis. While consumption is the cause of many deaths, it is by no means necessarily fatal. The *Bacillus tuberculosis* is usually of very slow growth and low virulence; it does not, like some microbes, produce large quantities of poisonous toxins which, upon entering the blood, cause rapid and extensive injuries to most organs. On the contrary, its action is at first largely confined to the spot where it has gained a lodgment, and at the outset the constitutional disturbances are slight. So insidious is the attack and growth of the germ that the patient does not at first even suspect its presence, but merely feels "out of sorts" or "run down." Only later, when the pathological processes have spread over a considerable area of tissue, are the symptoms serious, and frequently the disease is not recognized until almost irreparable damage is done.

It is chiefly for this reason that consumption claims so many victims, for the inroads of the disease are by no means unresisted by the living cells of the body. From the outset a struggle between these cells and the invading microbes takes place, and it should be better known than it is that in the majority of cases the human mechanism is the victor in the struggle. This is shown by the fact that autopsies on persons who have died of other diseases disclose in a surprisingly large percentage of cases *healed tuberculous lesions*, where the presence of the disease had not been suspected. In other words, the disease moves on to a fatal issue only when the *vital resistance* proves unequal to the defense, and the mortality from consumption would undoubtedly be exceedingly low were sufficient attention paid to the hygienic care of the body and the sanitation of its surroundings, by both of which the vital resistance is powerfully reënforced.

Many if not most students of the problem of tuberculosis now believe that infection generally occurs in infancy and childhood and that the vast majority of people become infected during the first few years of life. This means that the bacilli enter the body and some of them find lodgment in one place or another, in the lungs, in lymphatic glands, or in other organs and tissues. In these "foci" of infection the germs grow, multiply, and destroy the tissues upon which they are parasites; but the body has certain defenses against their invasion of adjacent tissues, for around such foci are constructed barriers within which the bacilli are confined and many but not all of them die. This may take place without any suspicion on the part either of parent or child of the true state of affairs. When the resistance of the organism is low the disease is not checked and proceeds to a fatal issue. Hence the high mortality from tuberculosis in childhood. Where the resistance is adequate the progress of the disease is checked, because the bacilli, *though not necessarily killed*, are prevented from invading the adjacent tissue, thereby extending the disease process. In this condition the child may grow into adult life without a suspicion of the latent tubercular infection lurking within.

Too frequently, however, the protective barrier breaks down, as the result of weakening of the defensive power of the organism by unhygienic living. The bacilli are thus set free to cause a "secondary" infection in the lungs, the joints, or in other organs. It is believed that most cases of consumption of the lungs are instances of such secondary infection.

If this view of the case is correct, it follows that every safeguard against infection should be thrown around children.

Their milk should come from sources known to be free from infection or, if not, it should be Pasteurized; promiscuous kissing of babies should be avoided and special care exercised to keep them, as well as children, away from known cases of consumption. In the second place, the defenses of the organism against the spread from foci of infection should be kept as perfect as possible by attention to the principles of hygienic living; in other words, by attention to personal hygiene.

This is in itself a powerful argument for attention to general hygiene, and it points out unmistakably the hygienic treatment of the disease when once recognized. *No reliance whatever should be placed upon drugs.* On the contrary, the patient, his family, and friends should recognize that the one hope lies in the hygienic conduct of life. The patient should live and sleep out of doors, if possible; he should fearlessly breathe cold air, but should protect the skin from chilling by warm clothing; if he cannot live out of doors, the windows of the living and sleeping rooms should be kept open, even in winter weather; the sleeping room should have light walls, and all curtains and draperies which limit the amount of sunlight should be dispensed with; the furniture of the room should be reduced to a minimum and should be such as can be easily cleaned; rest from anything but very moderate muscular activity, and from nervous strain, is absolutely essential. All these measures should be reënforced by abundant feeding with appetizing and easily digested food; the feeding, indeed, may be pushed to the extreme, may even be *forced* feeding, but only with easily digestible foods. In brief, *rest*, *fresh and cool air*, *sunshine*, and *abundant food* are the cures for tuberculosis, and, unless the disease has gone too far before it is recognized, they are almost certain cures.

While some *climates* are more favorable for the treatment of tuberculosis than others, — a cold, dry climate being preferable, — it should be understood that the treatment we have outlined has been used with excellent results even in the patient's own home, wherever that may be, and this hygienic treatment should be employed whether or not it is possible to go away from home. Continuous high temperature and high humidity, or dampness, are the main conditions which make change of climate desirable.

5. Sanatorium versus home treatment of tuberculosis. It is theoretically possible to give as efficient treatment of tuberculosis at one's own home as in a public or private sanatorium. In practice, however, better results are obtained by beginning the treatment either at a tuberculosis sanatorium or at least away from home under surroundings especially adapted to the "rest and fresh air" cure. In the first place, patients are thus withdrawn from the calls which are apt to be made upon them at home and so can give themselves up unreservedly to following the directions of their attending physicians. In the second place, with the vast majority of people it is only in this way that the exact regimen of the cure can be learned in all its details. After six months, more or less, spent under these conditions most patients with slightly advanced cases may return home, where family and friends may not only minister to their needs but may also maintain those cheerful surroundings which count for so much both in sickness and in health.

6. Importance of the early recognition of tuberculosis. In the struggle of mankind against this "great white plague" the provision of public and private sanatoria in which to begin the treatment is of prime importance; but no less important is the prompt recognition of the disease. Its approach is so insidious that all too frequently the patient has a mere fighting chance or even less than this before a physician is consulted and the diagnosis made. Everyone should understand that a run-down condition, especially when accompanied by steady loss of weight or rise of temperature, is suspicious, even when there is no cough. If these conditions do not yield readily to ordinary hygienic measures, it is wise to have a thorough physical examination by a competent physician. It may be positively stated that tuberculosis when recognized in its incipient or early stages is almost always curable; when its ravages have gone to the "moderately advanced" stage, the outlook is far more grave.

7. Typhoid fever. This disease is now believed to be due to the bacterial parasite known to bacteriologists as *Bacillus*

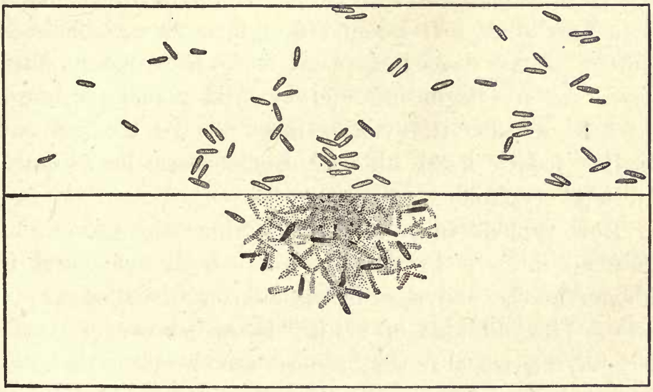


FIG. 135. Typhoid fever germs (*Bacillus typhi*) (highly magnified) Above, swimming free in normal blood serum; below, "clumped" or "agglutinated" in the serum of a typhoid fever patient

typhi, which, though observed by Koch, Eberth, and others about 1879, was first thoroughly worked out in 1884 by Dr. Gaffky, a pupil of Koch.

Typhoid fever has been well known since about 1840, previous to which time it was confused with *typhus* (*jail*, *spotted*, or *ship*) *fever* (see page 520). It is one of the worst maladies that afflicts mankind, for although not generally fatal in more than about 10 per cent of the cases, it is a *slow fever*, disabling the patient even when it does not kill and requiring weeks and often months for its course and for convalescence. It is widely distributed, probably all over the world, and, although less widespread than tuberculosis, it is still one of the chief causes of death. It is a disease which seriously damages the intestine and is one form of what is sometimes called "inflammation of the bowels." The microbe finds its way into the alimentary canal with food or drink and is believed to multiply in the intestine and to invade the body proper, producing a poisonous substance which causes the fever and otherwise injures the whole organism. The germs are cast off in abundance with the various excreta, and as diarrhea is a frequent (though not invariable) accompaniment of the disease, typhoid fever is called a *diarrheal disease.* At its beginning and in mild attacks throughout the whole disease the victim may not be confined to his bed, but may "keep about." Such cases are known as "walking" typhoid.

8. How typhoid fever is spread. Since the germs of this disease are present in the excreta, — both urine and feces, and even in the saliva, — it has been well called a "filth" disease. The old idea of a filth disease, however, was that filth bred disease and that almost any heap of dirt or rotting material might *generate* disease, especially typhoid fever, and inflict it on persons in the vicinity. This idea is now abandoned, for it is held that the germs of any one kind or species of disease can come only from other germs of the same kind; that is to say, typhoid fever can come only from a person or persons now having or having once had that disease. The excreta of such persons may readily convey it, and if food or drink are polluted in any way by such excreta, then the germs readily find access to fresh victims.

Unfortunately food and drink are oftener polluted than most persons realize. Water may be contaminated by sewage; milk, by the dirty hands of careless or unclean milkers; oysters growing in harbors or estuaries, by city sewers discharging therein; vegetables, by manure; and fruits or berries, by filthy hands. When we stop to think that filth may readily find access to food and drink in these and many other ways, it is clear that typhoid fever may still be called a filth disease, even if we understand by the term that it is a disease *conveyed by infected filth but not bred or generated by filth alone.*

9. The prevention of typhoid fever. This disease can be vastly reduced in amount and destructiveness in any community in which it abounds, by careful attention to the avoidance and destruction of its microbes and by maintaining high vital resistance through hygienic and wholesome living. Fortunately, moreover, a method is now in use for vaccinating against its attacks, much as is done for smallpox.

The microbes of typhoid fever may generally be avoided by the use of pure drinking water, pure milk, clean vegetables and fruits, raw oysters derived only from harbors and estuaries free from sewage, and, in general, by the use of pure foods and drinks. The microbes are readily destroyed by cooking at a high temperature and, in the case of the excreta of patients suffering from typhoid, by *disinfection*, which, under the direction of an attending physician, *should always be thoroughly carried out.*

It should never be forgotten that, contrary to the general impression, typhoid fever is really *contagious*, that is, may be "taken" by *contact* not merely with the patient but very readily with his excreta, or with his linen, or with any of his belongings soiled with his excreta. Even trained nurses sometimes seem to forget this fact, for not infrequently a trained nurse contracts the disease from her patient. Similar *secondary cases* of typhoid fever, especially in families in which the mother or sister attends the patient and at the same time prepares food for the rest of the family, are painfully common.

In the majority of cases of typhoid fever the victim is in an overworked or otherwise poor condition at the time of infection. This proves that the power of the body to resist the disease is strengthened by hygienic living. It is a mistake, however, to suppose that attention to general personal hygiene is a sure preventive, for persons apparently in the very best physical condition are sometimes attacked.

Finally, it must be admitted that it is not always possible to avoid infection, especially when one is away from home; and even at home control of the vehicles of infection is never complete. It is therefore fortunate that in what is popularly called typhoid *inoculation* or *vaccination* we have the means of producing an almost certain immunity from infection. For this purpose the microbes of typhoid fever are grown in vast numbers on suitable culture media. The microbes are then killed and their dead bodies injected subcutaneously. Usually three such injections are made at intervals. In its reaction to the presence of the dead bacilli the body acquires an immunity from infection by the living bacillus, this immunity usually lasting, on an average, two or three years. The introduction of this typhoid inoculation into armies as a routine measure has virtually eliminated a disease by which previously more soldiers were killed than by bullets. Whenever one is to be especially exposed to infection, typhoid inoculation becomes a hygienic duty, since thereby one not only secures himself against attack but also lessens the risk of becoming a source of danger to others. It must never be forgotten that every case of a communicable disease is a potential source of danger to the community.

A fever closely similar to typhoid is now known as *paratyphoid.* It differs from typhoid in its specific parasite and requires for its control a different serum or vaccine.

10. Diphtheria. This disease has long been known under the names "membranous croup" and "malignant sore throat," but it was not until 1884 that Loeffler, one of the pupils of Koch, detected the microbe now generally agreed to be its sole and only cause (Fig. 136).

It is believed that this microbe, *Bacillus diphtheriæ*, finding lodgment in the throat of a susceptible person, grows and multiplies there, secreting meanwhile a poisonous substance (or *toxin*) which injures the tissues of the throat and causes the formation of the *white spots* and *false membrane* so characteristic of the disease, and also damages the rest of the body after its absorption into the circulation, by producing fever, paralysis of particular parts, and sometimes death.

11. How diphtheria is spread. Inasmuch as diphtheria is a disease of the throat especially, it is easy to see that it must

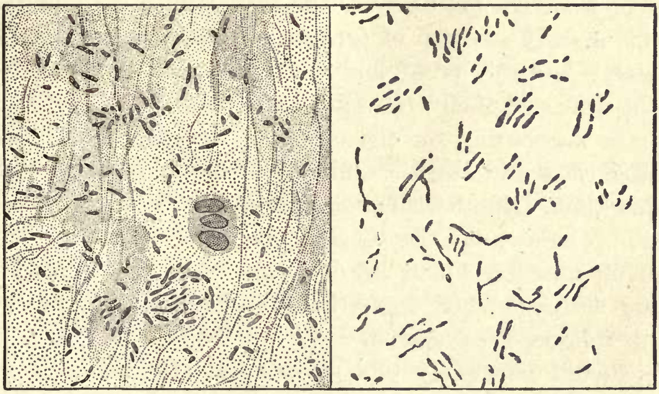


FIG. 136. Microbes of diphtheria (*Bacillus diphtheriæ*) (highly magnified)
On the left, as they appear under the microscope in discharges from the throat of a diphtheritic patient; on the right, after cultivation in the bacteriological laboratory

be chiefly conveyed from one person to another by *sputum and by objects which come in contact with the mouth or lips.* Kissing and fondling among children, or parents and children; fingers, which, especially in children, are too often in the mouth; books, handkerchiefs, pencils, playthings, and food bitten and passed from hand to hand, — all these may be vehicles of contagion and infection in this microbic disease. It may be spread also by sputum in dust, by milk infected by milkers suffering with the disease, by infected food, and possibly by pets, such as cats and dogs, and even birds, suffering from the disease.

12. The prevention of diphtheria. Diphtheria being primarily a disease of the throat and therefore distributed both by personal contact and by spittle, it would seem to suffice for its prevention to isolate patients having the disease as long as they are capable of communicating it to others, and thus cut off the escape and distribution of the germs. Unfortunately, however, in this, as in many other infectious diseases, persons often have the disease for some time before they or their friends discover the fact; and some mild cases of this malady (as also of typhoid fever and other infectious diseases) probably occur and run their course without ever having revealed their true character. Hence arises the difficulty of accounting for the origin of some apparently inexplicable cases and also the difficulty of stamping out a disease of this kind. Diphtheria is not an eruptive disease and ought, therefore, to be more readily controlled than smallpox, scarlet fever, or measles, which are doubtless often disseminated by means of scales shed from the skin during the "peeling" which follows the eruption.

It should be clearly understood that all kissing by persons having sore throats, or the mouthing of pencils or other objects by children, is a dangerous practice; and that fingers, which so readily find their way into mouths, may as easily as not carry infection to books, playthings, food, letters, or other objects which are "handled." Letters sealed or handled by diphtheritic patients or by persons attending them have probably at times conveyed the germs of disease to persons at a distance in whom the appearance of the illness seemed quite unaccountable. Here also, as in tuberculosis, care in the disposal of sputum is of great importance.

Within a decade the discovery of an antitoxic serum, *antitoxin*, has given us a novel and invaluable means of defense against the microbes of diphtheria by increasing the resistance of the human body so that it shall be no longer susceptible to the disease. But as this discovery means much more to hygiene than the control of this one disease, we shall devote to its careful consideration an entire paragraph farther on.

13. The spitting nuisance, as the habit of public spitting is often called, is not only a disgusting nuisance but a real menace to the public health, because, as will now readily be seen, it may be the means of spreading abroad diseases, such as tuberculosis and diphtheria, with which many persons — incipient cases, or "walking" cases — may be moving about. Fortunately the habit is chiefly confined to one sex, and this fact shows how easily it might be controlled if custom demanded.

14. Some other communicable diseases and how they are supposed to be spread. In the case of some of the commonest communicable diseases we are still in the dark both as to their precise causation and the ways in which they are scattered abroad. Concerning measles, chicken pox, and whooping cough, for example, we are still awaiting discoveries such as have already been made for tuberculosis and the other diseases described above.

We have also referred above (p. 375) to the fact that some colds or influenzas appear to be infectious. Attempts have been made to detect the microbes of the "grippe" and other influenzas, and figures are often given of germs found associated with disorders of this class. Fig. 137 is an example of this kind, although it is not safe to say positively that the microbes chiefly concerned have really as yet been identified.

But while we patiently wait for more light, we have good reason, because of their general character, to believe that these also are microbic diseases, caused likewise by microparasites transmitted either directly or indirectly from victim to victim. Experience has shown that the same kind of effort which tends to prevent diseases undoubtedly microbic tends to prevent these also; so that at present and for all practical purposes we may consider that we know enough about their causation and spreading to enable us to deal with them intelligently, fearlessly, and hopefully.

15. Scarlet fever, measles, and chicken pox belong to the group of *eruptive diseases*, a term derived from the fact that persons having any of them are usually, sooner or later, "broken out," or more or less covered with an eruption, or

FIG. 137. A so-called "influenza bacillus"

On the left, as found in the sputum in some "colds"; on the right, after cultivation in the bacteriological laboratory

rash. When this eruption heals, scales of the skin are shed, and the wide dissemination of these scales during the process of "peeling" is believed to be one reason why eruptive diseases are more contagious than some microbic diseases (like tuberculosis and diphtheria) which are not eruptive. Persons suffering from an eruptive disease should not be allowed to go about among other people until they have ceased peeling.

As for the prevention of measles, chicken pox, scarlet fever, and whooping cough, the only means at hand at present seem to be isolation and nonintercourse. To maintain or increase the resistance of the body no better means are known than good feeding, temperate living, and, in general, a wise and wholesome conduct of life; yet, even so, immunity is often purchased only at the cost of one or more attacks, and prevention by isolation is frequently difficult under the conditions of modern life, especially in tenements and crowded districts.

16. Summer complaint in children is a severe and often dangerous summer diarrhea, believed to be caused by microbes and apparently due in part to wrong feeding. In cities it appears to be closely connected with the use of stale milk, and is often prevented or overcome by using very fresh milk or, better, by Pasteurizing ordinary milk (p. 481). This is readily done by immersing bottles of milk in water and then heating the water to a temperature of about 160° F. for five minutes. If no thermometer is available, it will suffice to bring the milk nearly (but not quite) to the boiling point and keep it at that temperature for a few minutes.

17. Smallpox, a disease once so common that "scarce one in a thousand" escaped it, is now happily rare in most highly civilized countries. It is an eruptive fever, small pustules or pocks giving it its name, and while not as fatal as some of the diseases shortly to be considered, it is peculiarly loathsome and very apt to leave after it lifelong disfigurement, or pitting. It is hard to realize to-day the dread and fear with which our ancestors rightly regarded smallpox, and for this reason some people make much more of the slight discomfort and insignificant danger of vaccination than of the loathsome smallpox itself; but if communities ever cease to take the simple but indispensable steps required to prevent smallpox, outbreaks of the disease will undoubtedly remind them in alarming fashion of what they had previously escaped.

It is not yet absolutely proved, although it is generally believed, that smallpox is caused by microbic activity; but it is certain that it is extremely contagious, probably through the scales cast off from the skin of those suffering from it, with which scales the specific microbes are blown or handed about.

Experience has shown that great gain results from "isolating" or "quarantining" smallpox patients in a detention hospital (to which the name "pesthouse" was formerly given). Smallpox patients are thus removed and isolated, while those suffering from typhoid fever or consumption are not, partly because of the much greater contagiousness of smallpox and partly because of its graver and more loathsome character.

In smallpox, as in other diseases, wholesome living diminishes the danger of infection; but it is a matter of history that in the days when the disease was prevalent and the question was put to the severest test, general good health proved an unreliable defense. Fortunately, however, the human race, which was once so frightfully scourged by this disease, has discovered a more certain means of protection, which consists not in the warding off or destruction of microbes but in an enhancement of the powers of resistance of the organism, so remarkable as to constitute for extended periods virtual exemption, or *immunity*, from smallpox. The methods by which this extraordinary result is reached are known as *inoculation* and *vaccination*.

18. Immunity. The best of all defenses against any disease would be complete insusceptibility, or immunity, to it; for no matter how ingenious, elaborate, or complete the devices may be for preventing disease germs from finding access to the body, accidents may always happen which will allow them to enter. Immunity, or insusceptibility, to disease is therefore one of the principal aims of hygiene, one of the goals of sanitary science. Unfortunately natural immunity is not common, and artificial immunity is not easily conferred or acquired except in the case of one or two diseases, but there is good reason to hope that the future may have in store for the human race great gains in this direction.

Natural immunity means a natural insusceptibility to disease. It is usually constitutional and inherited. The lower animals, for example, are not susceptible to typhoid fever, and birds are immune to anthrax, although mammals take it readily. Diseases common to many species of animals appear to be the exception. In general, each species is immune to many, if not most, of the diseases of other species.

By *artificial immunity* is meant a similar exemption from disease not constitutional or inherited but *acquired* in one way or another. The most familiar method of becoming immune to any disease is to have the disease in question. For example, long before inoculation and vaccination were known, it was well recognized that persons who had once had smallpox were not likely to have it a second time, and such persons were, and still are, in demand as nurses for cases of that disease. Again, children who have had scarlet fever or measles or whooping cough are believed (and rightly) for that reason to be less likely to have the same disease a second time. There can be no question that protection is generally secured in this way, although cases are not rare in which such protection, even if once secured, is ultimately lost; for people sometimes have measles, typhoid fever, and diphtheria twice, or even oftener.

19. Inoculation for smallpox. The first great step towards the prevention of infectious diseases by producing artificial immunity from them was that of *inoculation* for smallpox.

For a century after the first English settlements in this country smallpox ravaged Europe and America, but in 1721 a novel and ingenious method of producing immunity from the disease was introduced into England from Constantinople, and quickly reached the United States. This method, known as *inoculation*, consisted in inoculating persons while in good health with *the virus of true smallpox* (not vaccine), for the purpose of causing them to undergo a mild attack of the disease while well and in good condition, so that they might avoid having a severe attack when unwell and in poor condition. Inoculation for smallpox was an effective preventive and met with wide acceptance and approval both in England and in the United States. It was extensively practiced for nearly a century, but was finally supplanted by the much safer process of vaccination, in which the inoculation was with vaccine (the mild and comparatively harmless virus of cowpox) instead of with the always dangerous smallpox virus.

20. Vaccination, one of the greatest blessings ever conferred upon mankind, was first invented in England, in 1796, by Edward Jenner, a young physician of Gloucestershire. It consists in the inoculation of the human being with virus derived from a cow having cowpox. A spot, usually upon the upper arm, is scraped by a lancet, so that the outer layers of the epidermis are removed; the spot is then rubbed with an ivory point, quill, or tube, carrying the virus. A slight and usually unimportant illness or indisposition follows, and the arm is sore for a time, a characteristic scar remaining. In some cases the illness is more serious, but deaths plainly due to mere vaccination very rarely, if ever, occur.

The immunity from smallpox produced by vaccination is remarkable and has been proved over and over again not only by the experience of armies and nations but also by actual experiment. It was formerly thought that "once vaccinated" was "always protected"; but to-day it is recognized that occasional revaccination is essential to complete immunity, the length of the period of protection usually fixed nowadays being not more than ten years. Indeed, so variable is the duration of the immunity in different individuals, and in the same individual at different times, that the only safe course is to revaccinate whenever there is an appearance of smallpox in the community. It should also be remembered that the vaccination may fail to "take" merely because the virus has been rubbed off by the clothing or because it was not effective to begin with. Consequently when any vaccination fails to "take," it is safest to try again a second or even a third time, especially if there is unusual exposure to the contagion of the disease.

21. Diphtheria antitoxin; other serums; immunology. As has been said above, inoculation against smallpox was begun in western Europe and America about 1721, and vaccination for the same disease at about the beginning of the nineteenth century (1796). No further progress was made in the art of immunizing until, in 1879, Pasteur succeeded in extending vaccination to some species of the lower animals, upon which he conferred immunity from certain diseases by using a modified (or, as he called it, attenuated) virus of the disease itself.

A much more fruitful discovery than Pasteur's was made in 1892, when Von Behring, a German bacteriologist, found that the serum of the blood of an animal immune to diphtheria differs from that of one not immune in that it is capable of neutralizing, both in a test tube and in the body of another animal, the poison (toxin) produced by diphtheria germs. This great discovery naturally led to the use of such neutralizing, antidotal, or *antitoxic serum* (*antitoxin*) in cases of diphtheria in man, and this use of it has now become general.

In order to obtain the antitoxin, horses are inoculated hypodermically with virus, or toxin,[1] of diphtheria (from

[1] If the animal were inoculated with the germ of diphtheria instead of its toxin we should have no control of its growth and the severity of the disease produced. By inoculating with carefully measured doses of the toxin, however, — which does not increase in amount, — we may produce the symptoms of diphtheria in very mild form and always have the course of the disease under control. Immunity is gradually acquired with but trifling discomfort to the animal, and the antitoxic serum is absolutely free from the germs of the disease. The statement sometimes made, that the use of antitoxin is liable to produce diphtheria because the animal was inoculated with the germs of that disease, is untrue, because such germs are never present in antitoxin properly made.

which all germs have been removed), at first in small doses but gradually with larger amounts, until they have become immune to heavy doses. The serum of the horse's blood under this treatment gradually becomes changed, so that it possesses antitoxic or antidotal properties. This serum (or antitoxin) is then carefully collected, bottled, and afterwards used to cure and sometimes to prevent cases of diphtheria in human beings.

Von Behring's discovery is probably one of the most beneficent ever made, because it has pointed out the way for the prevention or cure of other infectious diseases, by showing that when the disease is due to a toxin it may be possible in any case to produce an antidote (antitoxin) which shall neutralize and overcome it.

22. The science of immunology. We have described in some detail the method of producing immunity from typhoid and smallpox and also the preparation of the antitoxin of diphtheria. It will be observed that in all these cases the living cells of the animal (man, horse) are exposed either to the microbes of disease (as presumably in smallpox[1]) or to the products of their active growth (as in typhoid and diphtheria). The body of the inoculated animal is believed in all cases to react to the presence of the foreign poisons by the production of antitoxic substances capable of restraining or stopping the growth of the microbe, or of neutralizing the toxins it produces, or capable of both. In the cases of typhoid and smallpox these antitoxic substances are produced in and by the body to be rendered immune; in the case of diphtheria they are produced in another animal, and the blood serum of this animal is injected into the human being

[1] The virus containing the microbes used in vaccination, as previously explained, is that of cowpox and not that of human smallpox. Probably, however, cowpox is a mild form of smallpox. The microbes used are capable of causing only an exceedingly mild attack, but this confers the same immunity from the more virulent germs as if the patient had been exposed to the action of these virulent germs themselves.

attacked with the disease. In all cases the object to be secured is the presence of protective antitoxic substances, or *antibodies*, in the exposed or infected animal.

The history of other diseases suggests that this is a general reaction of living organism to the invasion of foreign microbes. In pneumonia, for example, we frequently meet the very striking phenomenon of the *crisis*. For a week or so the patient is extremely ill, and the symptoms become progressively and alarmingly worse from day to day. Then there is a sudden and complete change; the fever ceases, the distressing circulatory and respiratory symptoms improve, and convalescence sets in. The crisis marks the time when the infected organism has finally succeeded in producing enough of antitoxic substances or antibodies to check the further harmful activity of the invading microbes. The same thing is believed to be true whenever one acquires immunity by having an attack of measles, mumps, scarlet fever, etc. In all cases the immunity lasts as long as the organism continues to produce the antibodies. In pneumonia this period is comparatively brief; in typhoid it is considerably longer (two or three years); in smallpox it is longer still.

The production of these antibodies, or of this condition of immunization, presents many special complicated problems for each communicable disease. Hence has grown up a highly specialized and important branch of biological science — the science of immunology. Those working in this field seek to find the practical way to combat every communicable disease by making the antibodies of the disease effectively available to the organism attacked.

23. Tetanus, or lockjaw, is a comparatively rare disease, although in America, about the Fourth of July, it was formerly quite common among boys as a consequence of accidents attending the celebration of that anniversary. The lessening of these distressing and inexcusable accidents by the public agitation for a "safe and sane Fourth" is a good example of how hygienic reforms may be accomplished. The disease is a peculiar one, and prolonged muscular contractions or spasms are a characteristic symptom of its advanced stages. These spasms may cause the lower jaw to become more or less set or fixed; hence the popular name, "lockjaw."

The microbe of tetanus is well known, and is common in the intestine of herbivorous animals and in dirt in many places. It grows best in the absence of oxygen, and deep

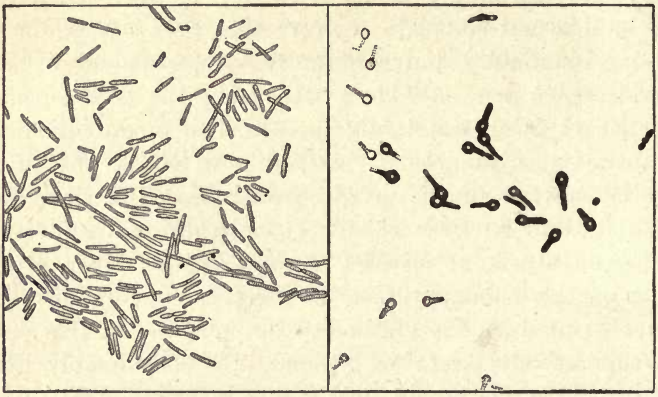


Fig. 138. Microbes of lockjaw (tetanus). After Kolle and Wassermann

On the left, in the ordinary rodlike stage of active growth; on the right, after having formed resting "spores" in the resting stage

or lacerated wounds, such as are made by toy pistols, rusty nails, tacks, etc., appear specially to favor its development.

24. Asiatic cholera is a microbic fever formerly greatly dreaded all over the civilized world, and still very destructive of human life in the East — for example, in the Philippine Islands. The germ of the disease was discovered by Koch, in 1883, in the bowel discharges of cholera patients in Egypt. Cholera appeared in Hamburg, Germany, in epidemic form as late as 1892, causing about eight thousand deaths and great alarm all over Europe and America. It is, however, easily prevented by the same means as are used to limit the chance of infection by typhoid fever (p. 493), and cholera need no longer be greatly feared in any clean and well-ordered community supplied with pure food and pure water.

25. Infantile paralysis, or anterior poliomyelitis. Those who live in New England or the Middle Atlantic States will recall the prevalence of infantile paralysis during the summer of 1916, and the alarm caused thereby in the territory

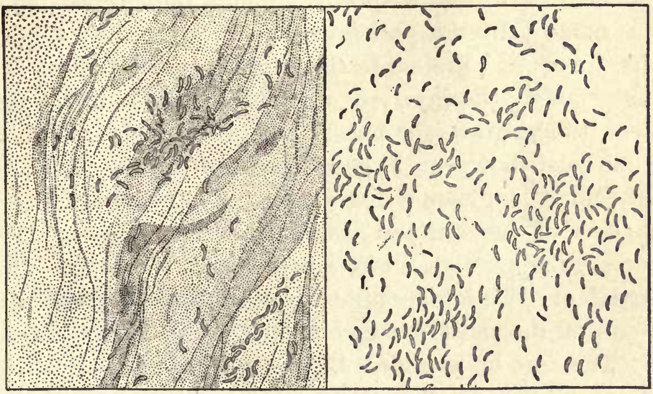


FIG. 139. Microbes of Asiatic cholera

On the left, as they occur in the feces of victims of the disease; on the right, after cultivation in the bacteriological laboratory

adjacent to the city of New York. Since the cause of the disease and its mode of transmission were only imperfectly understood, health authorities and the public generally were in the dark as to effective means of control. Cities and states were forced to the expedient of quarantine, which is always a confession of ignorance or helplessness. It was an instructive reminder of the days before Pasteur and Koch and Walter Reed, and emphasized, as nothing else could have done, the changed attitude of mankind toward plagues or epidemics of cholera, smallpox, typhoid, and diphtheria.

There can be no doubt that infantile paralysis is a microbic infection and that the virus is contained in the nasal secretion of persons suffering therefrom; at least this is true in certain stages of the disease. It can therefore almost certainly be transmitted from person to person directly by contact or possibly indirectly through articles of one sort or another. In many cases, however, no such transference can be detected even after the most thorough investigation; for which reason still other modes of transmission (for example, by insects) have been suspected, though not proved.

The name "anterior poliomyelitis" (Greek, *polios*, "gray"; *muelos*, "marrow") refers to the most distressing effect of the disease, namely the injury or destruction of the motor nerve cells of the ventral (or anterior) horn of the spinal cord. The microbe, however it gains entrance to the body, ultimately finds lodgment in the spinal canal and attacks the nerve cells of the cord and other parts of the nervous system. The resulting paralysis, often permanent, leaves the victim a partial or complete cripple for life, and this fact makes this one of the most dreaded of all communicable diseases.

26. The care of wounds. Proper care is usually taken of a severe wound by the physician or surgeon who is summoned to attend the case. Slight cuts, on the other hand, are frequently neglected as trivial affairs; and these cuts usually heal with no bad after-effects, either because no pathogenic organisms are introduced or because, if introduced, they are killed by one or another of the means of defense possessed by the body against microbic invasion. Infections of such wounds are, however, by no means of rare occurrence, and it is safer to give them thorough care whenever possible. The wound should be washed thoroughly with some antiseptic, such as a solution of corrosive sublimate (1 to 1000) or carbolic acid (1 to 40), and then protected by absorbent cotton until healed. Since the bacillus of tetanus grows only in the absence of oxygen, it is generally safer not to close the wound with anything like collodion, which entirely prevents access of air. The bleeding from an ordinary cut presents no danger of undue loss of blood from the body and, by washing out the wound before clotting takes place, is an important safeguard against infection.

27. Hookworm disease; its prevention. Some parasites are not microbic but macrobic, that is, large enough to be readily visible. Such are those of the diseases caused by tapeworms, stomach worms, pinworms, pork worms, and, most important of all, especially in the southern United States, Porto Rico, Central America, etc., hookworms. These last are minute parasitic worms which fasten themselves to the mucous membrane among the villi of the small intestine and live upon blood and lymph abstracted from their host. In persons badly infected large numbers of these parasites will be found in the intestine. They cause marked anemia (diminution in the number of red blood corpuscles) and, secondarily, disturbance of digestion, malaise, emaciation, and a marked loss of bodily and mental vigor. The eggs of the worms are discharged from the body in the feces and in this way are distributed wherever the soil is allowed to become contaminated with human excrement. In the soil the egg hatches into the larva.

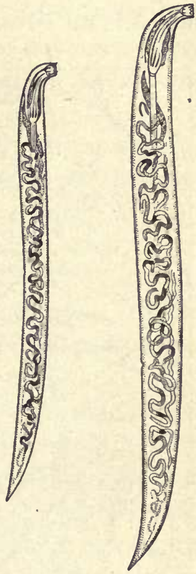


FIG. 140. Hookworms (female) After A. J. Smith

The larger is the Old World hookworm (*Ankylostoma duodenale* or *Uncinaria duodenalis*); the smaller is the American hookworm (*Necator Americanus*). Magnified about five times

The larvæ, either in the soil itself or on grass or other vegetation, attach themselves to the skin of the foot and bore their way into the underlying tissues, producing what is popularly known as "ground itch," "dew itch," or "water itch." Hence those going barefoot in regions where soil pollution is not prevented by the use of sanitary privies, or by other proper means of excrement disposal, are especially in danger. The larvæ ultimately bore their way into the blood vessels and are carried in the blood stream to the lungs. Here they enter the air cells and subsequently the air passages (bronchi and trachea), from which they are coughed up and swallowed, thus gaining entrance into the intestinal tract, where they fasten themselves and develop into the adult worms.

Fig. 141. Hookworms in tissues of the host

The best remedy is the use of thymol or other substances fatal to the worms in the alimentary canal but harmless or almost harmless to the patient. Prevention consists, on the one hand, in the use of suitable privies so as to avoid soil pollution; on the other, in guarding the feet with proper shoes and in the practice of general cleanliness.

Few diseases in warm countries are responsible for more ill health and economic inefficiency than hookworm disease. Boards of health and other agencies are to-day spending large sums of money to stamp out this disease so prevalent among the poorer classes of the population.

28. Trichinosis. This is another disease caused by parasitic worms, which find access to the body when uncooked or insufficiently cooked pork products are eaten. Raw hams, the lean of bacon, and sausages may contain a kind of almost microscopic worm (*Trichinella*, or *Trichina*) which sometimes occurs in the muscles of hogs, and which, if not killed by cooking, is capable of developing in the alimentary canal of man, boring into the tissues, and encysting in the muscles (especially the diaphragm), thereby causing severe disease and even death. Extensive epidemics of this disease (trichinosis) have occurred in Germany, in America, and elsewhere, due to ham and other pork products which have been eaten either raw or imperfectly cooked. Such foods are seldom eaten underdone or rare in America, but even here one should be careful to eat them only when *thoroughly* cooked or well done.

29. The itch, ticks, fleas, lice, flies, etc. A disease known as the *itch*, very common in the Middle Ages, was plainly communicable and at times epidemic. It is now known to be due to an insect (*Sarcopter*, "a mite") which bores through the skin to deposit its eggs and in so doing causes the itching which has given its name to the disease. *Ticks*, insects related to mites and spiders, are also common in some parts of the United States and produce serious sores and inflammations by fastening themselves upon the skin, from which they suck blood. *Lice* are also skin parasites, nesting often near the roots of the hairs and there depositing egg masses called *nits*. *Fleas*, *flies*, *mosquitoes*, *bedbugs*, and similar insects may also bite or sting, producing annoying though seldom dangerous wounds. When, however, besides biting, stinging, poisoning, or otherwise wounding their victims, insects become *carriers of disease germs*, they may no longer be merely troublesome pests but transmitters of pestilences and plagues of the most dangerous description. To them, therefore, and to the diseases which they may convey, we shall devote a special chapter.

CHAPTER XXXIII

COMMUNICABLE DISEASES CONVEYED BY INSECTS

1. Insects as carriers of disease. One of the most surprising discoveries of recent years is the important part played by insects in the transmission of disease. Insects have long been regarded as annoying, but it was not until 1890 that it was discovered by investigators of the United States Department of Agriculture that Texas fever (malaria of cattle) can be conveyed from one ox to another by parasitic ticks.

The tick is a small wingless insect closely related to the mites, and it was found that all that is necessary for the transmission of Texas fever is that a tick which has sucked blood from an ox affected with that disease shall afterward bite an ox as yet unaffected.

A few years later (1897) it was shown that human malaria (malarial fever), one of the worst diseases affecting the human race, especially in the tropics, is conveyed by the female of a certain kind of mosquito (*Anopheles*). Here also the insect must first bite a person affected with the disease, sucking some of the infected blood, after which it may bite a normal healthy person and cause infection.

Still more recently it has been proved that yellow fever, once a fearful scourge of the American tropics, is likewise transmitted by a special mosquito; that bubonic plague, formerly a world-wide pest and still common in certain Asiatic countries, may be conveyed to man by fleas which have bitten rats infected with plague; that ground squirrels likewise become affected and may serve as reservoirs of the same disease; that tsetse flies in Africa may act as transmitters of a mysterious disease known as sleeping sickness; while one of the most recent and most fruitful of all discoveries in this direction has been the intimate connection between certain lice, known as body lice, and typhus fever. It has been recently stated that two hundred and twenty-six different disease organisms are carried by insects to man or animals.

2. Malarial fever, or "malaria," is a world-famous disease, especially common in warm climates but also frequently occurring in the more temperate zones. It is by far the most important of all tropical diseases, for while it does not kill as readily as yellow fever and Asiatic cholera, it is much more common and disables a far greater number of victims.

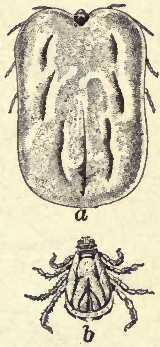


Fig. 142. The cattle tick of Texas fever. After Comstock

a, female; *b*, male

Malaria was long associated in the popular mind with low grounds and swamps. Experience has shown, however, that it cannot be caused by swamps alone, for many swamps and marshes are entirely free from malaria. Sometimes it has seemed to go with the digging up of earth; yet the earth has very often been opened and thrown about without causing malaria in the neighborhood.

The true source of this disease remained a mystery until in 1880 Laveran, a French investigator resident in Algiers, discovered in the blood of malarial patients a peculiar kind of microbe — not a bacterium, but an animal known as a *hæmatozoön*, or *sporozoön*, belonging among the simplest animals, or *protozoa*. Fig. 143 gives illustrations of some of the various forms of the microbe, and its life history is outlined in the description of the figure.

But even after the microbe of malaria had been detected no one knew whence it came or whether it lived outside of man or how it was conveyed to the victim. When, at last,

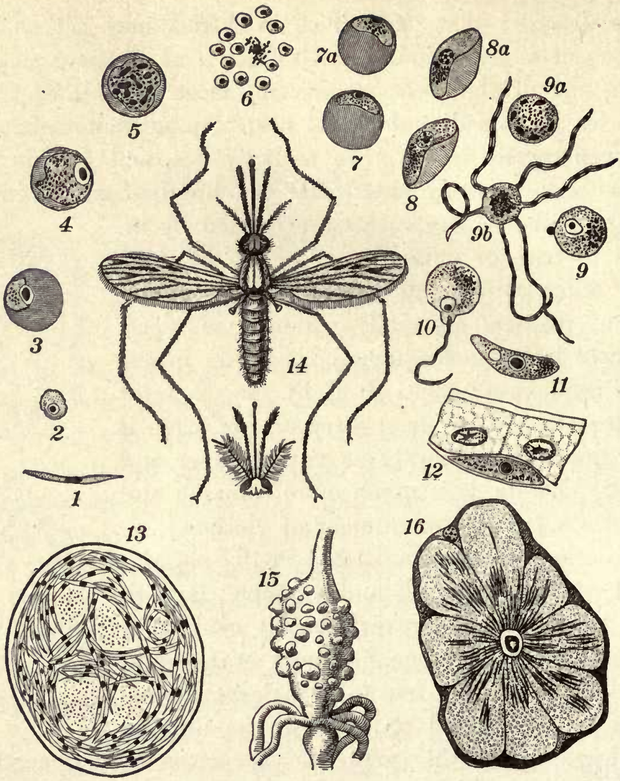


Fig. 143. The malaria microbe (*Plasmodium malariæ*) and a malarial mosquito. After Leuckart-Chun's wall diagram

1, the microbe; *2–5*, its growth in a red blood corpuscle; *6*, its multiplication and escape from the corpuscle (it is now ready to infect fresh blood corpuscles); *7*, *8*, crescentic forms of the microbe. For further development the microbe must be transferred from man to mosquito (by a biting, that is, a blood-sucking, mosquito).

In the stomach cavity of Anopheles: 9, female stage of the microbe; *9a*, *9b*, male stage; *10*, union of *9* with one of the vibratile arms of *9b*; *11*, the microbe resulting from *10*.

In the body proper of Anopheles: 12, The microbe (*11*) has penetrated the stomach wall of the mosquito and embedded itself on the outer (body) side of the stomach. Here it undergoes a process of growth, cell division, and multiplication (*13*), eventually forming "tumors" on the outside (body side) of the mosquito's stomach, as shown in *15*. From these tumors the microbes escape into the body cavity of the mosquito and find their way into the salivary glands (shown in section *16*). From these they are readily transferred (with the saliva) into a human body bitten by Anopheles.

14, female malarial mosquito (head of male below).

in 1897 the whole subject was cleared up, the solution of the riddle was found to be as simple as it was unexpected, for the vehicle proved to be a special *mosquito*, an insect long known as a pest but never hitherto suspected or dreaded as a carrier of disease. At once it became clear why malaria is a disease of some warm climates and some seasons, and why it "hangs about" some swamps and not about others.

3. How malaria is spread. The malarial microbe is a microparasite, spending a part of its life in man and another part in certain mosquitoes, which are thus its "hosts." A mosquito of the right kind bites and sucks the blood of a man having malaria, and, having thus become infected, bites other persons, injecting into them germs of malaria along with that poison which causes the familiar swelling often following a mosquito bite.

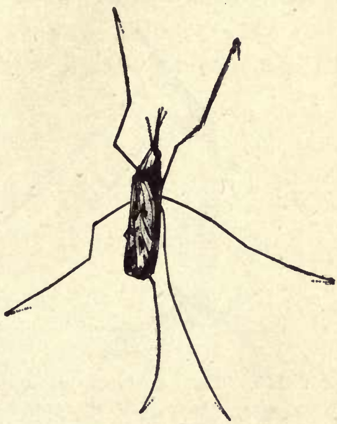


Fig. 144. *Anopheles punctipennis* (female). After a photograph from life by W. Lyman Underwood

Common in the northern United States

It is important to note that only one genus of mosquito (*Anopheles*), and that not the commonest in most places, seems capable of conveying the disease. Moreover, it is only the *female* Anopheles which can transmit malaria, and even that only after it has become infected by biting a person having the disease. Hence many mosquitoes, even if Anopheles, are harmless, as are all mosquitoes in regions in which either no Anopheles or no malarial microbes exist. For the causation of malaria three things are therefore required: namely, (1) malarial microbes, (2) female Anopheles, and (3) susceptible victims. Fortunately the first two do not always coexist, and malaria cannot occur where either the microbe or the mosquito is missing.

4. The prevention of malaria. Beyond a general reënforcement of the body by wholesome living, the only means yet known of avoiding this disease is the avoidance of mosquitoes in those regions in which they abound and in which malaria also occurs. If a region contains no malaria, the mosquitoes in it cannot produce the disease. If there are cases of malaria in the region, but no malarial mosquitoes, no fresh cases can occur. But if malarial fever and malarial mosquitoes coexist, then the only hope is to remove one or the other, and if possible both. For relief from malaria already fastened upon a patient, application should be made to a physician. For the extermination of mosquitoes from a neighborhood, all swamps and marshes must be drained, and pools of stagnant water either treated with crude petroleum or stocked with fishes that will feed upon and destroy the mosquito larvæ.

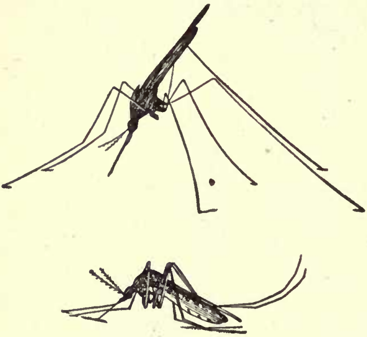


FIG. 145. The malaria mosquito (*Anopheles*), above, and the common mosquito (*Culex*), below. After photographs from life by W. Lyman Underwood

Showing a characteristic difference in the resting attitudes

5. Yellow fever. This is a disease greatly dreaded in the tropics. Little is known of the parasite beyond the fact that it is contained in a "filterable virus," that is, in something which, invisible under the microscope, passes through pipe-clay filters and is able to reproduce the disease. Like malaria, its mode of transmission was until recently entirely unknown, but it was generally believed that infection occurred by contact with the patient or with his belongings. This was disproved by experiments conducted in Cuba after the Spanish American War by a commission of United States army surgeons under Major Walter Reed. It was shown that, provided the room is effectively screened against mosquitoes, yellow fever is not contracted through contagion by those in the same room with the patient, but that transmission of the disease takes place when we have (1) a patient suffering from yellow fever, (2) a certain genus of mosquito (*Stegomyia*) that has sucked the yellow-fever blood, and (3) a susceptible person bitten by the Stegomyia. In these experiments the American investigators fearlessly exposed themselves to the possible contagion in screened rooms, and volunteers submitted themselves to the bite of mosquitoes which were known to have sucked the blood of yellow-fever patients. Several of these volunteers contracted the disease, and two of them died.

Fig. 146. The yellow fever mosquito (*Stegomyia*). After a drawing by L. O. Howard

It follows that, to control the disease, mosquitoes should be reduced to a minimum by the same means used in fighting malaria, but, still more important than this, that every yellow-fever patient should be kept in a room effectively screened from mosquitoes until complete recovery. As the result of the introduction of these measures, Havana, which was formerly cursed by yellow fever, has been virtually freed from it; and the suppression of yellow fever in Cuban ports, from which formerly the disease was frequently exported to the United States, means much to the southern states of the Union. In 1905 a disastrous outbreak of yellow fever in New Orleans was fought on this mosquito theory with entire success, and since that time the dread of yellow fever as a plague is a thing of the past. Another result of the advance of our knowledge with regard to mosquitoes as transmitters of disease is the building of the Panama Canal, which was rendered possible only by the complete control of malaria and yellow fever during the course of its construction.

Stegomyia occurs in the southern United States as far north as Norfolk, Virginia, and is found north of this latitude only when brought into ports on fruit ships in summer time.

6. The plague (bubonic plague). The plague is the most famous of all the great epidemic diseases of history. It has

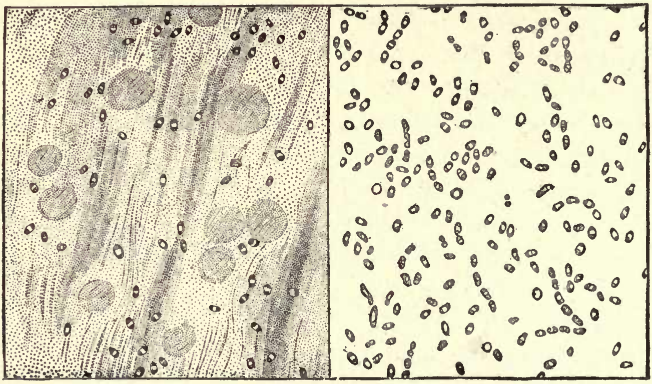


Fig. 147. Microbes of plague

On the left, as they occur in the swollen lymph glands; on the right, after cultivation in the bacteriological laboratory

repeatedly ravaged Europe, and is still very common in some parts of Asia, such as India and China. The *Black Death*, which is probably a severe form of the bubonic plague, was a severe epidemic disease of the fourteenth century, when it is said to have killed off twenty-five million people, or from one fourth to one half of the entire population of Europe.

The bubonic plague is so called because it is accompanied by enlarged lymph glands, or buboes, which look black in advanced stages of the disease (hence "black" death). A particularly severe and fatal form of this plague is that in which the lungs become quickly inflamed as in pneumonia, and hence the term "pneumonic" plague sometimes applied to this form.

All forms of true plague are believed to be transmitted chiefly through the agency of rats and fleas, rats even more than human beings being susceptible to the disease. Rats affected with plague are bitten by fleas which, thus becoming infected, later feed upon human beings and inoculate them with the germs derived from rats. Fortunately it is only certain kinds of fleas which readily transmit the disease, so that if, as happened in England in 1910, plague appears among rats in a certain district, only a few human beings may suffer, either because the proper fleas are wanting or because of the cleanly habits of the people.

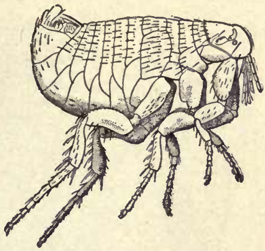


FIG. 148. A common flea (*Xenopsylla cheopis*) parasitic upon man. Enlarged about eight times

In order to prevent plague it is all-important to get rid of rats and fleas, and in plague-stricken districts preventive measures against the disease are directed almost wholly to the capture and destruction of rats. In the Philippines, for example, rat catching is an important branch of sanitary work, and on the Pacific coast an outbreak of bubonic plague was successfully held in check by sanitary officials who devoted their energies almost exclusively to the destruction of rats and of ground squirrels.

An important sanitary measure against the plague is to prevent the rats aboard ships from infected countries from getting ashore, and for this various devices have been invented, such as rat guards upon ropes and hawsers. Sanitary garbage pails, which make it impossible for rats to steal food from these receptacles, are also considered important by those engaged in rat destruction, the aim being to starve out all rats.

7. Typhus fever and body lice. Typhus fever (spotted fever, ship fever, jail fever, or camp fever) was formerly one of the commonest and most destructive of all slow or continued fevers. Between 1830 and 1840 it was found that under the name of typhus fever at least two specific diseases were confused, and since that time typhoid ("like typhus") fever has been clearly distinguished from typhus.

Under improved sanitary conditions typhus fever has rapidly declined — much more rapidly than typhoid fever. Recent studies have shown that, nevertheless, typhus fever does from time to time occur, especially in our largest cities, and that it is common in countries such as Mexico, where modern sanitary conditions are comparatively rare. Still more recently it has been found that this disease is transmitted by lice, and especially by the so-called body louse, or "grayback" (*Pediculus vestimenti*) (Fig. 150, *a*). Since the outbreak of the great European war of 1914 typhus fever has frequently appeared in camps and prisons, and serious epidemics of the disease have broken out in various places, particularly in Serbia. No causative microbe of typhus has hitherto been discovered.

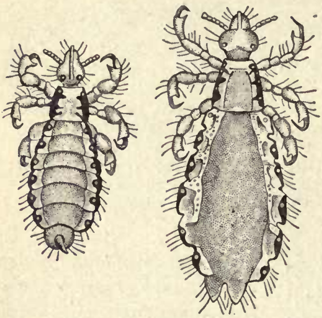
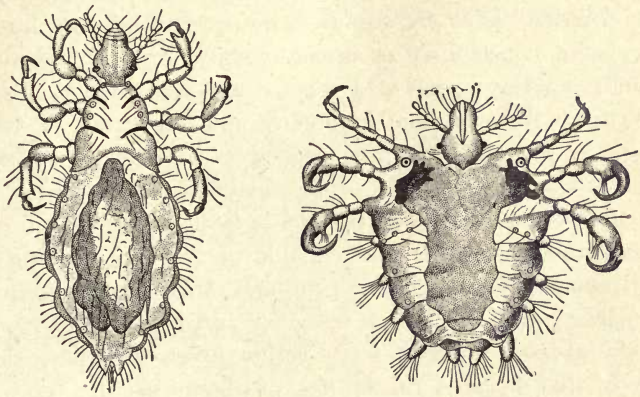


FIG. 149. The head louse (*Pediculus capitis*) (much enlarged). After Neveu-Lemaire

The larger is the female

The body louse is not very different from the more familiar louse of the head (*Pediculus capitis*) shown in Fig. 149, but lives chiefly in the clothing of soldiers, prisoners, or others suffering from defective personal cleanliness. Under such circumstances lice are especially abundant in the seams of the trousers, where they appear to find refuge and from which they make excursions to the skin of the victim, sucking blood and causing great irritation. If perchance any such lice have already fed upon a person affected with typhus fever, then they may readily communicate the disease by biting other persons.

Here also the three conditions referred to under malaria and yellow fever must occur, namely, (1) a victim of the disease from whom (2) an insect parasite may suck infected blood, carrying it to (3) a person hitherto unaffected.



a *b*

FIG. 150. Two species of lice, parasitic on man. After Neveu-Lemaire

a, female of the body louse, or grayback (*Pediculus vestimenti*) (much enlarged); *b*, the crab louse (*Phthirius pubis*, or *inguinalis*) (greatly enlarged)

8. Tsetse flies and sleeping sickness. A disease has long been known in certain parts of Africa under the name of sleeping sickness, for the reason that its victims constantly fall asleep and are awakened with difficulty. The mode of infection was a complete mystery prior to the discovery that a susceptible person could become infected with the disease through the bite of a peculiar kind of fly — the tsetse fly — which had previously bitten a victim of the disease.

9. Carriers, vehicles, or transmitters of disease. While it is true that disease is not a substance or entity but a condition of the body and cannot therefore exist apart from the person or persons affected, it is otherwise with the living germs, which produce disease. These, being generally minute, often invisible, and frequently hardy, are readily carried about and scattered abroad very much as small seeds are sometimes distributed by winds and sometimes by animals, especially birds. Strictly speaking, anything by which germs may be distributed is a carrier, a vehicle, or a transmitter of disease; for example, water, air, milk, or meat; mosquitoes, fleas, or man. The term "carrier" is at present used, however, chiefly for human beings who, consciously or unconsciously, are carrying about within them the germs of a disease and are giving off such germs from time to time in breath, sputum, urine, or feces.

For our purposes we may regard as carriers *all animals, including man, capable of holding and giving off disease germs.* The case of a tuberculous patient is typical; he or she may be a veritable reservoir and capable of discharging tubercle bacilli at any and all times. Similarly, the malaria mosquito (*Anopheles*) may be both a reservoir and a source of supply of malarial-fever microbes; the yellow-fever mosquito, of the germs of that disease; the rat flea, of plague bacilli; the body louse, of typhus fever; and mankind, not merely of tuberculosis but also of diphtheria, scarlet fever, measles, chicken pox, typhoid fever, leprosy, smallpox, and venereal diseases.

10. Flies as transmitters. A review of the preceding pages, especially those devoted to malaria, yellow fever, and plague, illustrate how important are insects in the transmission of infectious diseases and the causation of epidemics. Mosquitoes, fleas, and lice have already been sufficiently dealt with. It only remains to consider briefly one other kind of insect, the fly.

The common house fly (Fig. 151) has long been recognized as a noisy and irritating nuisance, but it is only of recent years that it has come to be regarded as a possible carrier of disease. There is now good evidence that the germs of almost any infectious disease, material from which may be accessible to flies, are transmissible by their means from one human being to another. Flies are essentially scavengers and feed upon almost any waste organic material. While feeding they also walk upon it and touch it with their tongues, so that through their tongues, their excreta, and their feet they may readily convey germs from infected matter of any kind, including excrement or dead bodies.

It is sometimes held that a very large amount of typhoid fever is transmitted by flies. While there is reason to think

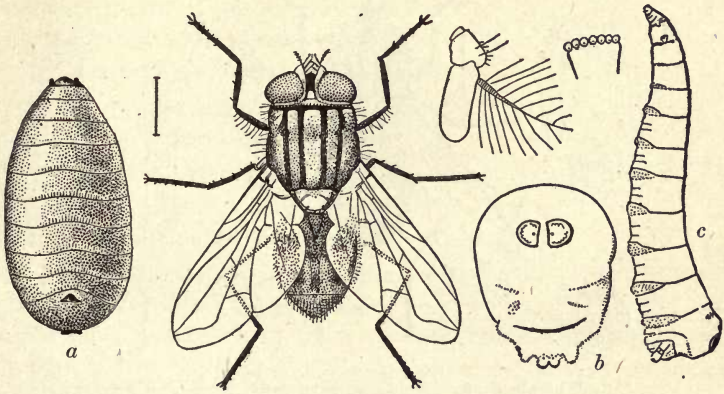


Fig. 151. The common house fly (*Musca domestica*) (enlarged 4–5 times). After L. O. Howard

a, egg case; *b*, pupa; and *c*, larva (or maggot)

that this particular aspect of their activity may at times have been exaggerated, there is no doubt that flies are filthy, disgusting scavengers, and that they should never be allowed to obtain access to pantries or come in contact with foods. Houses, and especially dining rooms, kitchens, and the like, should be carefully screened with mosquito netting or wire gauze to prevent the entrance of flies. Flies are also especially out of place in a sickroom.

Other kinds of flies bite their victims and suck their blood. Examples are the various species of horse fly, the black fly of the northern woods, and the stable fly (*Stomoxys calcitrans*) shown in Fig. 152. The possibility of the transmission of disease by these biting flies is obvious, and certain of those mentioned, as well as other biting insects, have from time to time been suspected of acting as the vehicles of infection in such diseases as infantile paralysis, pellagra, etc. Although the responsibility for epidemics of these diseases has not been successfully fastened upon these insects, no one

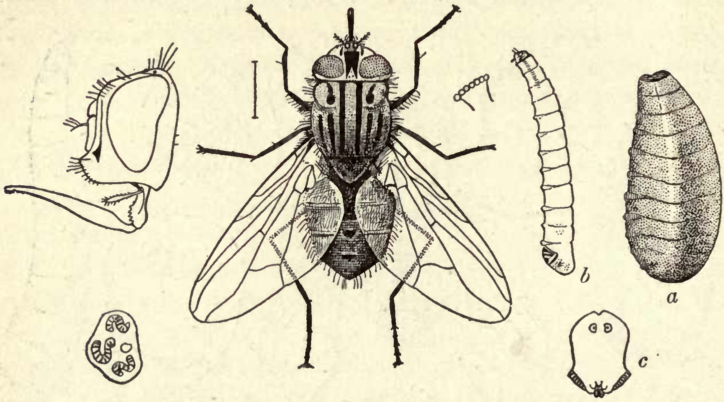


FIG. 152. The stable fly (*Stomoxys calcitrans*) (enlarged 4–5 times). After L. O. Howard

a, egg case; *b*, larva; and *c*, pupa

can deny that they constitute a potential source of danger and that their numbers should be kept down as far as possible.

11. The elimination of flies. Four chief methods are used to control or eliminate the fly nuisance. These are (1) to kill flies with "swatters" or insect powders, (2) to screen dwellings and other buildings, (3) to prevent the breeding of flies, and (4) to catch the flies in traps. The first and second methods can at best accomplish no more than the reduction of the number of flies within houses, leaving countless new ones to come in when doors are opened. The third and fourth methods seek to rid the premises around the house of flies, and it is clear that if this end can be attained, swatting and screening, so far as flies are concerned, become unnecessary. It should be generally known that this end is easily attainable.

Flies breed chiefly in horse manure, and they are especially attracted to garbage and other decaying matter as a source of food. If horse stables could be entirely eliminated from cities, there would doubtless be few flies in those cities; but this is not possible, and is even more impracticable in towns and rural districts. Keeping stalls clean, screening manure pits, promptly removing manure, and even treating it with chemicals to prevent the breeding of flies therein, have been recommended and tried out, with results which are unsatisfactory, chiefly because it is not possible to secure unremitting vigilance and coöperation on the part of all individuals in these measures.

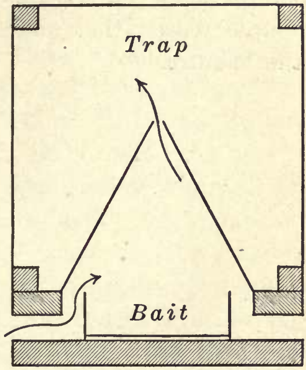


FIG. 153. Vertical section of a fly trap

The fourth method — catching the flies in traps — depends for its success, first, upon the use of a properly constructed and operated trap, and, second, upon preventing the access of flies to their favorite foods (especially garbage), except when the fly must enter a trap to get it. Flies usually crawl upwards, — seldom downwards, — and this peculiarity of behavior is utilized in trapping them (Fig. 153). Over the bait is placed a conical or tentlike chamber of fly netting, with its sides converging to a narrow ($\frac{1}{8}$ inch) hole or slit at the top. After feeding on the bait the fly crawls upward through the slit into the trap, which consists simply of a framework of wood or iron with sides and top of fly netting. Traps may be baited with garbage of any kind — fish cleanings being one of the best — and placed out of doors at a distance from the house. Sometimes the lid of the garbage can is fitted with such a trap, the lid fitting loosely enough on the can to allow the fly to enter it. Success in all cases depends upon preventing the access of flies to any other food than that in the trap.

By the use of these traps it is possible to catch virtually all flies, even on premises where there are stables and where no measures are taken to prevent their access to manure. Under such circumstances flies do not multiply, for the simple reason that almost none are left to deposit eggs in the manure.

CHAPTER XXXIV

PUBLIC SUPPLIES OF FOOD, WATER, AND GAS. PUBLIC SEWERAGE

1. Communities and public supplies. Public supplies and public services are designed to meet those wants or demands which many families have in common, and the chief supplies are those of water, ice, gas, and milk. Fuel, transportation facilities, libraries, parks, playgrounds, baths, laundries, bakeries, and the like are examples of other public supplies or services. Formerly in rural life each family was comparatively independent, but the modern town or city family, and to a great extent the rural family, depends upon some public supply for nearly everything that it has or uses: for books, upon public libraries or bookshops; for clothing, furniture, household utensils, etc., upon shops or stores; for food, upon markets; and sometimes even for housing, upon hotels or other public houses.

2. Public supplies as public conveniences and safeguards. When such public supplies or services are well regulated, cheap, and abundant, they may often be superior in safety, comfort, and convenience to private arrangements for the same purpose. In a city it is easier and cheaper to buy milk than it is to keep a cow. It is also better to do so, because cows in cities must be under unnatural, if not unwholesome, conditions, and the milk may suffer in quality. It is more convenient to draw water from a tap than from a well, and city wells are generally objectionable because usually subject to contamination. It is more convenient, more cleanly, and safer in a city to connect a house with a good sewer than to supply it with a privy and a sink drain. Public supplies may thus serve not only as conveniences but also as sanitary safeguards.

3. Public supplies as public dangers. On the other hand, public supplies must be well arranged and well regulated or they may become sources of public danger. If, for example, the water supply is allowed to become polluted, a whole community may be stricken with typhoid fever or some other infectious disease. Hundreds of cases of typhoid fever have been known to occur among the customers of a single milkman whose milk supply had become infected. Sewage-polluted raw oysters have been known to cause the illness of dozens of persons at a single public banquet.

It is easy to see that the very convenience and widespread use of public supplies which are not pure makes them doubly dangerous. If a private supply becomes polluted, ordinarily only a single family suffers; but if a public supply is impure, hundreds or even thousands of persons may perish. The moral is plain: *The purity of public supplies should be thoroughly established at the outset and carefully maintained.* If, as is often the case, public supplies are owned or controlled by the municipality, then no persons should be put in charge of them who are mere politicians or in any other way unfit to act as guardians of the public welfare. *Expert scientific supervision of public supplies is indispensable for efficiency, for economy, and for public safety.*

4. Food supplies, public and private. The supply of foods to families or individuals may be largely from private sources, as in the case of a farm upon which many foods may be produced. But with the growth of cities and large towns, food supplies are more and more shared *in common* by many persons or families, while certain necessities or luxuries of life, such as fish, sugar, salt, tea, coffee, spices, are, with rare exceptions, always obtained from public supplies.

Furthermore, even on the farm, specialization often leads to the raising of only one thing or a few things, such as cotton, corn, or wheat, and so to dependence on public supplies for other things which might be raised if it were worth while. For example, most farmers in New England might cultivate sugar maples and make from the sap of their own trees a year's supply of maple sugar, the purity of which they could control; but most of them prefer to raise other things which they can sell or exchange for ordinary cane sugar, of the purity of which they have no knowledge. Flour nowadays is generally bought in barrels or bags taken at random from the output of distant mills over which the buyer has no control. Meat of various kinds is often purchased from a public cart, shop, or market; fish and shellfish, yeast, butter, eggs, cream, spices, canned and dried foods, are likewise obtained from special dealers, whose stores are drawn upon by many families and are therefore public supplies. Obviously impurity or adulteration in any of these public supplies may injure, or at least defraud, an entire community.

5. Impurity of foods. This may be of many kinds and many degrees, some of them of little or no hygienic significance. An excellent spring water, for instance, may not be chemically pure (that is, containing nothing but water), and yet may be hygienically wholesome; and milk might conceivably be somewhat adulterated with distilled water without perceptible damage to the health of the community.

We may, for convenience, distinguish three principal kinds of impurity in foods: the first kind, caused by the addition of some cheaper substance, either already present in the food (as of water to milk) or altogether foreign to it (as of sawdust to ground spices). Such impurity is produced artificially, intentionally, and fraudulently, and is known as *adulteration*. It may or may not be prejudicial to health, but it is always a cheat.

The second kind of impurity of foods, known as their *infection,* consists in the occurrence in them of parasites or microparasites, such impurity being as a usual thing entirely accidental and unintentional, though often due to ignorance, negligence, carelessness, or uncleanliness. It is always prejudicial to the public health, but is not often due to a desire to cheat.

A third kind of impurity is that due to the use of unfit or unclean or diseased raw materials, disgusting to the taste and destructive to the appetite. This again arises either from negligence or the desire to cheat.

6. Adulteration of foods. The commonest and most familiar adulteration of food is that of milk by water. Water is so abundant and cheap, and mixes so readily with milk, that it offers a constant temptation to dishonest milkmen who profit by the sale of such milk. It is often difficult for the consumer to detect this adulteration, even if he suspects the cheat; but it is easy for the chemist, and large cities should keep milk inspectors and analysts constantly on the watch, in the interests of the public welfare. In some cities the fines imposed upon dishonest milkmen more than repay the cost of the service.

But while milk is the food whose adulteration is most familiar, it is by no means the only adulterated food. Coffee, spices, beverages, sirups, honey, vinegar, and many other foods are subject to serious adulteration, and most states and countries are obliged to maintain laboratories devoted to the protection of the public against the adulteration of foods and drugs. Massachusetts has such a laboratory in the Statehouse in Boston, conducted by the State Board of Health. Some of its revelations are surprising and instructive. Milk, for example, is treated not infrequently with artificial coloring materials and preservatives such as formic aldehyde, sodium carbonate, and boracic acid. Of about one thousand samples of suspected milk examined chemically during certain summer months, nearly three per cent contained preservatives. Chocolate and cocoa likewise have frequently been found to be adulterated with wheat or sugar; coffee with roasted peas, wheat, pea hulls, chicory, and sometimes bark, wood, and charcoal; honey with cane sugar or glucose; lard with cottonseed oil; maple sugar with other sugars; maple sirup and molasses with glucose; pepper with rice and buckwheat; cloves with bran, sawdust, and charcoal; mustard, one of the most commonly adulterated of all spices, with rice, cornstarch, etc.; cider with salicylic acid. Worse yet, some so-called patent medicines, which profess to effect cures, contain the very substances, such as alcohol and morphine, the effects of which they are supposed to overcome.

7. The infection of foods by parasites and microparasites. Another and, from our standpoint, much more important kind of impurity sometimes occurring in foods consists in their infection by disease-producing organisms, such as parasitic worms or microbes, — for example, the germs of typhoid fever, scarlet fever, diphtheria, etc. Here again milk has the unenviable distinction of serving as a familiar example, for some of the worst epidemics of typhoid fever that have ever occurred have been traced conclusively to the infection of some milk supply by persons suffering with that disease.

Other foods subject to infection and capable of conveying disease are those which are either occasionally or regularly eaten uncooked, — for example, shellfish, such as oysters and clams; vegetables, such as celery, parsley, water cress, lettuce, tomatoes, cabbage; and fruits, berries, and the like. The danger lies in the fact that they may have been handled by persons themselves dirty and suffering from infectious diseases; or they may have been grown on fields manured with sewage or other fecal matters containing germs of disease. For all these dangers there is but one sure remedy, namely, *sterilization by cooking at a high temperature.*

But this, in the nature of the case, is impossible for many of the foods cited above.

Some fruits (oranges, bananas, melons, etc.) are naturally protected by their skins, and are consequently especially wholesome. Others (such as cherries, plums, apples, pears) should be washed thoroughly or rubbed with a damp, clean cloth before being eaten. Still others (grapes, raspberries, strawberries) may be immersed in water and imperfectly washed, though they are seldom really cleaned by this process. Moreover, such "washing" is apt to injure the texture or flavor of delicate fruits and is sometimes avoided on that account.

After all has been said and done, preventive measures may fail and some risks must be taken. The final defense must often come from that vital resistance, that good general health, which it is the special object of hygiene to secure and promote. Life is valuable and health is precious, but either or both may be safeguarded at too great cost. Undue anxiety about foods, or even about life and death, is unworthy of those who have at most but a few short years to live, and who in those few years have many better things to do than merely to keep alive. "'T is not the whole of life to live."

8. Food preserving and preservatives. Processes such as canning, and cold storage in wells, cellars, refrigerators, etc., are of immense value to the human race as conveniences and for the saving of surplus foods. The packing of pork in brine, the salting, smoking, and drying of fish, the corning of beef, and the pickling of vegetables are familiar examples of other kinds of food preserving. In these latter cases the foods are saved from spoiling by substances (brine or vinegar) which inhibit the growth of putrefactive microbes and are therefore called *antiseptics.* There are many other antiseptics besides brine and vinegar, and chemistry is constantly adding to the number. Some of the more important are boracic acid, formaldehyde (formalin, or formol), and salicylic acid.

A difficult and delicate question arises when we ask whether the introduction of chemical antiseptics into foods makes them impure or dangerous. It is obvious that the use of salt to preserve fish, of brine for packing pork or corning beef, of smoke for preserving fish, hams, and dried beef, and of vinegar for pickling have been approved and sanctioned by generations. On the other hand, the use of boracic acid or formalin in milk is an undesirable practice, and at present the employment of any chemical antiseptic in food preserving must be regarded as of doubtful justification.

Some food substances contain acids which may attack the tins in which they are put up for the market. Blueberries, for example, readily corrode tin cans, forming salts of tin which in large amounts are harmful. The use of glass is therefore preferable for preserved foods whenever practicable; but the long-continued and very extensive use of tin cans for tomatoes, peas, beans, pears, etc., without known harm, indicates that for many foods tin cans may be used without much, if any, danger.

Sometimes food products, such as peas, clams, etc., are treated chemically in order to make them more attractive. French peas (canned) have frequently been found to contain copper, and canned clams are sometimes bleached to make them whiter. It is needless to say that such treatment is almost always objectionable, even if not positively dangerous.

The best preservatives, hygienically speaking, are heat and cold, which, carefully applied, may be wonderfully effective. The processes of canning and preserving are too familiar to need description, but it is not always understood that if the temperature employed is high enough and sufficiently long-continued, it is of great hygienic value, because it tends to destroy any disease germs which may be present. It must, however, be remembered that while the high temperature used in canning destroys the germs of disease, it also destroys the vitamines contained in the food (for full discussion see pp. 232–234). Refrigeration, or cold storage, although without such disinfecting influence, is also a preservative of immense economic value.

9. The purity of public water supplies. Public water supplies should be derived from the purest possible sources. Villages and small cities are often supplied from driven wells or open basins located near a lake or a river, and thus receive *ground water* (see p. 455). Large cities and many small ones often secure their supplies from lakes, ponds, or rivers, or from smaller streams, the water of which is stored in reservoirs. Supplies of this sort are called surface-water, rather than ground-water, supplies, and the water from them is naturally softer (see p. 458).

Ground-water supplies are apt to be of good quality but limited in quantity. Surface-water supplies are generally ample in quantity but more easily subject to pollution. For this reason they should not, as a rule, be drawn from thickly inhabited districts or from rivers, lakes, or small streams into which sewage or other polluting matters may find their way; and they should never be drawn from such sources unless they have first been purified in some manner.

Some cities, like Brooklyn (New York) and Lowell (Massachusetts), rely for their public water supply in part or wholly upon driven wells; some, like Boston, New York, and Liverpool, upon water collected in large reservoirs from streams upon comparatively uninhabited watersheds; and some, like Philadelphia, Paris, St. Louis, London, Hamburg, Lawrence, Albany, upon impure river water which is purified by filtration, or otherwise treated, before it is distributed to the citizens.[1]

[1] The student, unless already informed, should familiarize himself with the sources and the possibility of pollution of the public water supply, if any, of his own village, town, or city, and should satisfy himself, if possible, as to its purity.

It was formerly thought that running water sufficiently purified itself, although as early as 1874 a Royal Commission of experts on water supply reported in England that "there is no river in the United Kingdom long enough to purify itself from any sewage introduced into it even at its source," and the river Thames is more than two hundred miles long. It is true that sewage or other filth in streams often disappears, and that great improvement in polluted streams frequently takes place; but such "self-purification" is too often partial, incomplete, and untrustworthy.

In many cases the disappearance of obvious pollution is due to a mere *dilution* of the filth with purer water, and such dilution may greatly improve or even "purify" it. A drop of ink in a quart of water makes a mixture far less inky than the original drop. On the other hand, dilution does not necessarily mean destruction. A flock of birds may be lost sight of, but not destroyed, by scattering, and the purification of sewage filth should mean its destruction as such and its conversion into harmless substances. Much true purification does take place in a flowing stream, but this is not usually adequate, and towns and cities nowadays are generally turning toward filtration, or other artificial treatment on a large scale, of waters which for any reason are suspected of possible contamination. Some of these municipal purification works are elaborate and costly, as, for example, those in Albany, Philadelphia, St. Louis, Ithaca (New York), Lawrence (Massachusetts), and Washington.

10. Public gas supplies and their dangers. There is no more danger from the products of combustion of illuminating gas than from those of oil or other illuminating materials. The air of rooms naturally becomes heated and more or less vitiated by these products, just as it does by human breath or any other waste product of oxidation; but illuminating gas properly burned is no more dangerous to life than is kerosene oil or any similar illuminant. Unburned gas, on the other hand, escaping from pipes or fixtures, is often extremely dangerous, both because it is poisonous and because in certain proportions it forms with air an explosive mixture.

Illuminating gas is generally either "natural" gas, drawn ready-made from the earth, or gas made from gasoline, oil, wood, coal, or coal and water, and hence known as oil gas, wood gas, coal gas, or water gas, as the case may be.

11. Natural gas consists chiefly of marsh gas, or methane (CH_4), this making from 90 to 97 per cent of the whole. It never contains more than one half of 1 per cent of carbonic oxide (CO), a quantity too small to do serious damage. Though irrespirable (that is, not fitted to support life), and though it forms exploding mixtures, natural gas is not poisonous. It may even leak into an apartment in considerable quantities without endangering life or seriously damaging health.

12. Coal gas is made by distilling soft, or bituminous, coal, and consists chiefly of hydrogen and marsh gas, with smaller amounts of carbonic oxide and other compounds of carbon. It contains from 6 to 10 per cent of carbonic oxide, a highly poisonous gas, and cannot be admitted into living or sleeping rooms in any great quantity without extreme danger to life. It also readily forms explosive mixtures with air.

13. Water gas is made by passing steam over red-hot coal or coke (carbon), which decomposes the water vapor, producing, among other gases, an abundance of carbonic oxide. As it leaves the generator, water gas burns with a pale-blue flame only. For lighting purposes it is therefore enriched by the addition of naphtha or other vapors which give it good illuminating qualities. But even after this treatment water gas generally contains from 25 to 30 per cent of carbonic oxide, and is therefore extremely poisonous.

In cities supplied with water gas, cases of asphyxiation and death from gas poisoning are common. These come chiefly from ignorance (in blowing out the gas instead of shutting it off) or carelessness (in turning the gas on again after extinguishing the light), or from suicidal intent, or drunkenness, or from leaky fixtures, or from change of pressure, — a light turned low being extinguished by a decrease of pressure in the pipes, and the gas escaping into the room afterwards when the pressure is renewed.

The most remarkable (and often the most extensive) cases of poisoning by illuminating gas are those in which the inhabitants of houses or apartments have been poisoned by gas which has escaped from a broken or leaking main in an adjoining street. In these cases the gas makes its way underground to the basement of the house in question, and then, partly robbed of its warning odors by passage through the earth, rises through the house to sicken or kill those within. Whole families, and even groups of families, have occasionally been poisoned in this way, even in houses or tenements not piped for gas at all. The fact is that heated houses act like chimneys in producing a strong up-draft; and in winter, when windows and doors are shut tight, this draft sucks in air from the surrounding ground. If the ground air happens to be charged with gas from a leaky main, both air and gas may enter the house and sicken or even kill the inmates, although the house itself is not supposed to receive any gas. It has been estimated that "14 per cent of the total product of gas plants leaks into the streets and houses of the cities supplied."

Headaches and malaise (a convenient term for "feeling poorly") may be caused by small and imperceptible leaks of illuminating gas, and great care should be taken to have all gas-fitting well done, and all leaky joints or fixtures made perfectly tight, especially if the gas used is water gas, now very generally supplied to the public in American cities, either in full strength or diluted.

One of the great advantages of lighting houses by electricity is that it does away with all possibility of gas poisoning except that from leaky mains in public streets, already referred to.

The use of gas for heating and cooking requires special caution, owing to the large quantities used and the temporary connections often employed (pp. 442 and 444).

14. The purity of public milk supplies. Milk is one of the most universal and most important of foods. It is also one of the most peculiar, in that it is a secretion drawn directly from the bodies of living animals. This remarkable animal secretion, when fresh, is very sweet, smooth, and bland to the taste, but on exposure to the air generally spoils quickly and sours. It is obviously not the air alone which causes it to sour, for milk is easily kept sweet a long time if kept in a cold place or if scalded when it threatens to turn sour.

The spoiling and souring of milk are caused by certain bacterial microbes which, having got into the milk as it was drawn, or later from dust, air, dirt, or unclean pails or strainers, live and multiply enormously at the expense of the sugar and other foodstuffs which milk contains. The so-called lactic-acid bacteria, in particular, thrive in milk, especially if it is kept warm, and spoil it by converting the milk sugar (lactose) into milk acid (lactic acid).

Milk that is pure should be free from dirt, and sweet rather than sour, but such milk is unfortunately not always easy to obtain, especially in cities. A black sediment in milk indicates *dirt* (usually cow dung), and so does a "cowy" taste. Milk may also be adulterated with water, with antiseptics, or with other substances, as has been shown above (p. 530). But the most serious impurity in public milk supplies is the occurrence of *germs of contagious or infectious diseases.* Many epidemics of typhoid fever and diphtheria have been conclusively traced to a public milk supply which served as the unsuspected vehicle of the disease. In all of these cases *uncleanness* of some sort — on the farm, in the dairy, among the milkmen, or elsewhere — is believed to have been always at the bottom of the trouble.

Persons supplying milk to the public should take pains to keep their cows healthy and their cow stables clean; to milk only after careful washing of the hands, pails, cans, strainers, etc., and also only after cleaning the udder of the cow; and it should always be remembered that milk is a rich animal secretion which readily supports bacterial life and therefore should be scrupulously guarded against any invasion of dirt or disease. To secure rich, pure, clean, and fresh milk in cities, a higher price must probably be paid than has been the custom hitherto. The demand is for better, purer, cleaner milk, and for this it is reasonable to expect that more must be charged.

It should also be remembered that the number of bacteria in milk, unlike that in water, does not depend simply on the number that get in, since germs multiply very rapidly in this rich food supply. Hence milk as soon as drawn should be *chilled* as far as possible before delivery. The mere souring of milk lessens its digestibility, especially in the case of infants, so that it is a matter of hygienic importance, particularly in warm weather, to hinder the growth of bacteria in it by immediate cooling as soon as drawn from the cow, and keeping as cold as possible afterwards.

It must also be borne in mind that the milk-producing industry, while one of the oldest known to man, is still largely in a primitive condition. What is needed is a more scientific knowledge of the subject, more intelligence, skill, and cleanliness among those engaged in it, and, finally, *expert supervision* both on the part of the producer and of the sanitary authorities of cities, with better returns for the farmer.

15. Public sewerage and the disposal of sewage. One of the most beneficent procedures in any community is the establishment of a system of public drains which shall quickly and effectually remove all liquid and some solid wastes, especially the excreta of human beings and other animals. Well-built sewers not only do this but also carry off much ground water, making the soils of cities drier and therefore more wholesome. The term "sewerage" is applied both to the act of draining and to the system of sewers; the word "sewage," to the contents of sewers.

The disposal of the sewage of cities and towns is often a very serious, difficult, and costly problem. Sometimes the sewage can be safely emptied into a river, a lake, or the sea, but more often it is necessary to *purify* it, either upon land (where it may be made useful, though rarely profitable, for agricultural purposes), or by chemical treatment, or by microbic (bacterial) action through cesspool or filtration processes. The problem of the final disposal of sewage is not yet fully solved, and at the present time is engaging the attention of the world's ablest sanitary engineers.

CHAPTER XXXV

HYGIENE AND SANITATION OF TRAVELING, AND OF PUBLIC CONVEYANCES, PUBLIC HOUSES, ETC.

1. Migration, past and present. One of the most striking characteristics of the present as compared with the past is the increased and increasing movement of masses of people not only permanently out of one country (emigration) and into another (immigration), but also temporarily from place to place, and back and forth (traveling). Such migration inevitably removes the traveler, temporarily at least, from one environment, and subjects him to another and often very different one; so that from the hygienic point of view a change of this sort is of great importance and interest. It also often affects the environments of others besides the migrant himself, by introducing into those environments new elements of disease.

2. Traveling and change of scene. Even before starting upon a journey, conditions for the prospective traveler have often begun to change. The bustle and the thought of the necessary preparations constitute a kind of excitement, sometimes pleasurable, sometimes wearisome, accompanied, it may be, by temporary loss of appetite or even sleeplessness (especially in children), or by other abnormal conditions sometimes described by the phrase "journey proud." With the start come leave-takings, farewells, and partings more or less unusual and exciting, and then begins a series of tolerably rapid changes of environment or scene. The body is moving and possibly shaken about or jarred; unusual and shifting scenes fall upon the retina and come before the mind, calling for attention and arousing new sensations; strange sounds are heard, strange odors detected; the air (if in an open vehicle) beats against the face, and the ordinary atmospheric "blanket" is diminished or otherwise interfered with.

Arrived at a stopping place or the journey's end, streets, houses, and hotels are new or strange; strange faces meet the traveler; there are strange rooms and walls, strange furnishings, strange sounds and odors, — in short, a strange or unusual environment.

All this may or may not be wholesome, according to circumstances on the one hand and the individual on the other; but it is certainly stimulating and physiologically exciting, as may be readily proved by observing its effects upon children and the aged. The change of scene is only one element in the hygiene of travel, and its value must be determined by weighing it together with other equally influential factors (namely, the change of occupation, the change of air, and the change of food), and, finally, by applying all these considerations to particular cases or individuals.

3. The change of occupation. It is an old saying that "all work and no play makes Jack a dull boy," and experience teaches clearly enough that a change of occupation is wholesome. One of the best features of travel is that it necessitates a change of occupation. A common expression contains the idea of "going away from home to get a change." One of the most valuable characteristics of the home is the repose and restfulness which result from its uniformity of conditions, and one of the best things about travel is the mild stir and excitement involved. Routine and regularity of occupation are, on the whole, the more natural and normal, and "a steady job," whether it be in shop, home, or factory, on farm, plantation, or shipboard, in bank, school, or professional life, is naturally sought and prized by everybody.

And yet most persons profit from time to time by "a day off," or a vacation, or a journey which affords change of occupation with freedom from responsibility. Once on his way, the traveler is not responsible for the train or the steamer, for the cookery or the beds, for the house or hotel, or its furnishings or management; and this freedom from responsibility is a complete and often a refreshing change.

4. The change of air. It is difficult to say in what way and to what extent a change of air is beneficial in traveling. Much of the benefit, even when attributed to the "change of air," is no doubt really due to other things, such as the change of work and the change of scene; but after making all allowances, it would still seem to be true that a change of air has a perceptible effect, and often does great good or great harm. Air that is drier or damper, or warmer or cooler, than usual, or air in the forest or by the sea, often seems to have decided effects for good or for evil, all other conditions remaining apparently much the same. At times, obscure atmospheric influences at home, unknown to ourselves, may be the source of lessened vital resistance, and so of a lowered tone of general health, and the change of air may be the means of restoring normal conditions by removing the obscure cause of trouble. Moreover, when the change is from the close, "stuffy" air of an office to the open air of country or of sea, with their agreeable odors, there is a "bracing," or stimulating, effect which reacts favorably upon the entire constitution, but especially upon the nervous system. The tendency to "fill our lungs" with it is only a sign of the general beneficial influence upon the system as a whole. Many a case of "the blues" has been successfully overcome by this simple expedient of a change of air.

On the other hand, air as a vehicle of infection may affect the traveler unfavorably, for he must almost inevitably be exposed to air (as well as to other things) which has recently been in contact with persons having incipient tuberculosis, diphtheria, measles, typhoid fever, or other infectious diseases. To this subject we shall return in the next section but one.

5. The change of food. It is uncertain how much or how little influence a change of food has upon the organism. It is commonly believed that a change of food is often beneficial, or the reverse, and that much of the good or bad effects of travel is due to the inevitable change of diet and of cookery which goes with it. How far this is true is unknown, but it is easy to see that a simpler diet for some and a more abundant diet for others may in itself alone be helpful. It is doubtful if any special virtue resides in "sea food," or in "country living," or in "camp cookery," apart from that which consists in its palatability or its novelty,—qualities which affect appetites and therefore nutrition; but in so far as a change makes food appetizing or acceptable, such food is, of course, more valuable to the body. However this may be, there can be no question about the increased danger of infection from food and drink taken at random from unknown sources.

6. The dangers of infection away from home. At home the traveler, in theory at least, has an environment well under his control; but when he starts upon a journey,—whether afoot, or riding, or driving; by automobile, railway, steamship, or other means of conveyance,—he enters into new environments, of whose precise nature he is ignorant, and which are usually beyond his control. Of the sanitary or unsanitary condition of the water supply, ice supply, milk supply, etc. he is usually ignorant; and he may at any time be thrown in contact with persons suffering from infectious diseases, especially in a mild or incipient form. The public vehicle (carriage, wagon, car, or omnibus) in which he travels, the hotels, rooms, chairs, and even the beds which he uses, may have been recently occupied by diseased persons. His laundry work may be done or delivered by workers suffering from contagious diseases; uncleanliness may attend the preparation and serving of his food. In short, in leaving his own familiar and controllable environment and passing into others unfamiliar and beyond his control, the traveler clearly takes large risks.

7. Safeguards of the traveler. If it be asked what one can do to protect himself or his family from the dangers of travel, it may be pointed out, in the first place, that it is often better not to travel at all. When one is in poor condition, although a change to some new scene whose hygienic conditions are known to be good is likely to be beneficial, a railroad journey with frequent stops is apt to increase the danger of infection at a time when vital resistance is low. When a journey is advisable, the traveler should try to avoid marked fatigue, which always diminishes vital resistance and thus predisposes to disease; he should seek to avoid unclean hotels, unclean conveyances, badly aired rooms, and unclean fellow travelers; he should avoid the use of public drinking-cups, public towels, public razors, and the like; he should, if possible, *drink only waters of established reputation*; he can, if need be, forego the use of raw milk, raw oysters, and other uncooked foods the antecedents of which he knows nothing about, and he can take other obvious and useful precautions that will suggest themselves as he goes along.

But, after all, it must be admitted that precautions, even if rigorously observed, will often prove insufficient, and also that too much thought about them, or about the dangers of travel, would rob it of most of its advantages. People always have traveled and probably always will travel without much consideration of the dangers involved in traveling. Some risks must always be taken, even at home, and most travelers cheerfully accept the necessary risks for the sake of the gains to be derived. With the increase in the amount of traveling, some of the risks are gradually decreasing, and in highly civilized countries adults in robust health who know how to take care of themselves may now go upon a journey without very much more risk of infection than they would undergo if they stayed at home. This is probably less true of children, for children and old people are not only more easily excited and more easily fatigued but they also suffer more severely from exposure, and children are especially apt to contract infectious diseases when away from home.

8. Public drinking cups. These should be avoided by travelers, theater-goers, and all persons in parks or other public places. Few sights are more distressing to a sanitarian than to see (on a hot day in a crowded railway car) men, women, and children, of all ages, sorts, and conditions, clean and unclean, sick and well, one after another in rapid succession applying their mouths to the one public drinking cup. If the student will once carefully observe for himself the use to which this cup is put during even a short journey under such conditions, he will realize that every traveler had better carry his own drinking cup, or, in default of this, go thirsty. In some theaters, between the acts, trays containing glasses of water are passed to patrons in their seats. Here also the lips of many persons touch successively the same glasses, and one who is wise will avoid the obvious danger involved in using any of these glasses, which may have become infected. Sanitary drinking fountains in which, by a simple device, the obnoxious common drinking cup is made unnecessary, are now being rapidly introduced in parks, schools, and other public places.

9. The influence of travelers upon the environment. We have thus far considered chiefly the effects of strange environments upon the traveler, but before leaving the subject we must not fail to point out some of the reactions of travelers upon the environments in which they journey or linger. Many epidemics of infectious diseases have sprung from germs left by travelers, and most of the great plagues and pestilences of history have followed the routes of pilgrims, caravans, crusaders, conquerors, traders, or travelers. "Walking cases" of typhoid fever, diphtheria, etc. are perhaps most dangerous to the public health, and tramps, peddlers, and other roving characters do much to spread disease. Persons coming down with an infectious disease, such as typhoid fever, are very apt to leave off work and go a-fishing, sometimes upon or along the shores of a public water supply, which they may unwittingly contaminate. Life away from home has its dangers for the traveler; it is no less true that life at home has its dangers, these often arising from travelers themselves.

10. Public conveyances, because they are used promiscuously by the well and the ailing alike, are subject to infection, and for this reason carriages, cars, and steamboats should be kept clean and occasionally should be thoroughly disinfected. Steamboats and steamships are essentially floating hotels, and should be treated as such. Sleeping cars bear less resemblance to public houses, and may be cleaned partly by washing, partly by blasts of compressed air, and partly by disinfectants, and, when properly cared for, are less likely to endanger health than are many hotels. Their lavatories should be kept scrupulously clean and should be frequently disinfected. In modern times vast improvements have been made in all kinds of public conveyances, in the direction of greater steadiness, less noise, better heating, better air, and better lighting. The public drinking cup, even, has been forbidden in many states and ought to be abolished altogether.

11. Public houses. Hotels and other public houses may be either clean, wholesome, and restful, or unclean, noisy, and unsanitary. Owing to the fact that their population is constantly changing, they are far more exposed to infection than are private houses, and great pains should be taken to keep them always in good sanitary condition. The simplest (iron) bedsteads are the best, and in hotels all carpets, draperies, etc. should either be avoided or subjected to frequent and thorough cleaning. The kitchen, especially, requires careful supervision to insure cleanliness, and in the laundry the linen should be so treated as to be sterilized during the process of washing. Employees should be instructed in the art of cleanliness, and any suffering from contagious or infectious diseases should be excluded or quarantined. All lavatories should be kept scrupulously clean and should be frequently disinfected.

12. School buildings. The proper construction, operation, and care of school buildings is a very important branch of public hygiene. In these buildings children spend much of their lives removed from their ideal physical environment; during a large part of this time they are at desk work, with its possibilities of acquiring deformities, such as round shoulders and faulty curvatures of the spine; their eyes must be used in near work with its danger of eyestrain; they are more exposed to communicable diseases and too frequently to improper heating and ventilation. These and other disadvantages of life at school have led to special study of the problems of school hygiene by experts. It is not possible to sketch this field even in outline in this book. It is, however, something in which the public is vitally interested and everything possible should be done to reduce to a minimum the hygienic and sanitary dangers of school life.

13. Public places, such as streets, parks, playgrounds, and cemeteries, are dangerous only when infected. Dirty streets are unsightly and disagreeable, but it is very hard to trace the source of much disease directly to them. Nevertheless, few things sooner or more agreeably impress a visitor than clean streets, and in the lower portions of the town or city clean streets are particularly important because the streets are the home and the playground of the children of the poor. Pavements in cities should be hard and nonabsorbent rather than porous, and should be kept clean and free from rubbish.

14. Public parks are desirable for fresh air, recreation, rest, and change of scene, and in these respects are important hygienic factors in city life. They are of special benefit to those living in tenement houses or under crowded conditions. Public playgrounds minister to the needs of the same class of people. Their importance can hardly be overestimated, since they furnish to city children almost the sole opportunity for normal physical development and some contact with nature. It has been well said that "the boy without a playground is the father of the man without a job." But here also wise supervision and cleanliness are the conditions of hygienic success.

Public cemeteries in America are usually well conducted and unobjectionable from the hygienic standpoint. The objections sometimes urged against them as centers of infection and sources of disease are seldom well founded. *Cremation*, or the burning of the dead, is slowly but steadily growing in favor and has much to recommend it from the sanitary standpoint, since it prevents slow decay and destroys completely all germs of disease. Near most of the larger American cities there are now one or more crematories.

CHAPTER XXXVI

PUBLIC PROTECTION OF THE PUBLIC HEALTH

1. The public health. By this term is meant the health of the community, and of some community every family and every individual is a member. The public health is obviously of vital importance to the individual; and, conversely, the health of the individual is of vital importance to the community. Personal hygiene, or the hygiene of the individual, and public hygiene, or the hygiene of the community, are thus closely bound together. Not only because it is his duty, but also because, from the selfish point of view, it is to his advantage, the individual should, therefore, interest himself in and seek to promote the public health. If, for example, smallpox appears in his community, he cannot afford, even from a selfish point of view, to fail to do his best to aid in suppressing it. If he himself falls ill of smallpox, his neighbors and the whole public naturally feel a similar interest in isolating him and preventing the spread of the disease.

For these and similar reasons, people living in communities, and especially in villages, towns, and cities, by common consent usually elect or appoint a few of their own number as sanitary authorities or officials to attend to matters affecting the public health. The citizens thus chosen are endowed by common consent with special powers and privileges, and are generally designated as the board of health, or health commissioners. Sometimes, especially in small communities, there is no formally organized board of health, the duties of such a board being performed by some other governing body of the community, such as the selectmen, county commissioners, and the like.

2. Boards of health, their powers and duties. Very much as boards of police are chosen by the people to preserve public order and to prevent disturbance and crime, so boards of health are chosen to preserve the public health and prevent disease and death. And as the police officer could not possibly do the work assigned to him without unusual powers and privileges, these sometimes involving a considerable interference with personal liberty, so the health officer cannot do the work expected of him without unusual powers and privileges. But it should never be forgotten that in each case both the officers themselves and the powers which they possess exist by the common consent of the community, which desires, and thus provides for, protection at the cost of surrendering some personal rights and privileges. Boards of this sort derive their powers solely from the consent of the majority of the community which they serve, and those members of the community who disapprove of their existence, powers, and acts must either persuade the majority to adopt a different policy, or must submit, or must go elsewhere.

Among the important *powers of boards of health* are the rights of quarantine, isolation, entrance and search, and vaccination. The Public Health Service may, at the ports of the United States, quarantine a vessel, perhaps full of passengers impatient of delay and eager to land, even for many days, subjecting the owners, passengers, and others to great inconvenience, expense, and damage. A board of health, finding smallpox in a hotel or boarding house, may quarantine or isolate the building, surround it by police, and forbid all persons to enter or leave it, thus causing great alarm and annoyance to the inmates, great damage to the proprietor, and a heavy expense to the community. A board of health may declare general vaccination necessary for the protection of the public health, and may even enforce vaccination upon the careless, reluctant, or resisting. It may forbid a dairyman to sell milk thought to contain typhoid-fever or other disease germs, thus causing the dairyman great inconvenience and even financial ruin. In all these cases the board is, as a rule, simply obeying the wishes of a majority of the community, and those who are delayed, constrained, or financially injured have to submit as best they may, unless the general sentiment of the community undergoes a change in their favor.

The *duties of boards of health* are manifold. Some of the most obvious and general are usually prescribed by public statute or ordinance. Such, for example, are the following in the state of Massachusetts:

The State Board of Health shall take cognizance of the interests of health and life among the citizens of the Commonwealth. It shall make sanitary investigations and inquiries in respect to the causes of disease, and especially of epidemics and the sources of mortality, and the effects of localities, employments, conditions, and circumstances on the public health; and shall gather such information in respect to those matters as it may deem proper, for diffusion among the people. It shall advise the government in regard to the location and other sanitary conditions of any public institutions.

Others are less general and more specific, like the two following:

The State Board of Health shall have the general supervision of all streams and ponds used by a city or town as sources of water supply, with reference to their purity, together with all springs, streams, and watercourses tributary thereto; and shall have authority to examine the same from time to time and inquire what pollutions exist and what are their causes.

When the Board of Health of any city or town has had notice of the occurrence of a case of smallpox or of any other disease dangerous to the public health in such city or town, such Board of Health shall, within twenty-four hours after the receipt of such notice, notify the State Board of Health of the same.

A nation may and should have a national sanitary authority charged with the protection and promotion of the public health and provided with large powers; it should also be supplied with trained experts and money enough to enable these to deal with emergencies, to study large sanitary problems, and to carry on researches into the causes of disease and the improvement of methods for their prevention. Germany has such an organization in its Imperial Board of Health, and the United States, for a short time, had a National Board of Health. At present the United States Public Health Service is charged with all interstate public-health functions.

The states also, in the United States, have for the most part their own boards of health, but such boards do not always have very large powers, these being reserved for the so-called local boards of the various cities and towns. It is believed by many experts that a larger grant of powers and resources to state and national boards would be of substantial benefit to the public, and would secure for all a much more constant and efficient sanitary protection.

3. What the individual may do to protect the public health. The first duty of the individual to the public health is to remember that he himself, his family, his house, and all his belongings constitute one important and fundamental element in the health of the community of which he is a unit. He should therefore seek, first of all, to maintain and promote good health in himself, in his family, and in all his household; for the prevention of disease and premature death in one household is a distinct and genuine contribution to the better health of all other households.

In the next place, he should cheerfully conform to all reasonable regulations of the board of health or other sanitary authority of his community, duly prescribed by them under powers conferred by the community as a whole.

Finally, he should inform himself as fully and as accurately as possible upon hygienic and sanitary subjects, in order not only to protect and promote his own health and that of his household but also to enable him to become an intelligent, critical, and yet coöperative member of the community, thus doubly aiding in preserving and promoting the public health.

Having done, or tried to do, these three things, the good citizen has still one further duty of the utmost importance to perform for the maintenance and betterment of the public health (which, as we have shown above, is also of great consequence both to himself and to his family), and that is, to aid and assist in all their good works boards of health and all others in sanitary authority. This he may do by reporting the existence of cases of infectious disease, nuisances, etc.; by helping to secure the election or appointment of intelligent, upright, and expert officials; by loyally upholding such officials in the performance of their duty; by refusing to countenance opposition to necessary public procedures, such as vaccination, gas inspection, plumbing inspection, the placarding of houses containing cases of infectious disease, the isolation of patients, etc.; and in many other ways which are sure to arise.

At times this individual responsibility for public health involves personal inconvenience and hardship, severely testing the good citizenship even of those most desirous of coöperating with the public-health authorities. This is well illustrated in the case of diphtheria. When antitoxin is given in this disease, the toxin produced by the bacteria is neutralized in the blood and tissues and is thus prevented from injuring the organism; but not all the bacteria are necessarily killed by this treatment. Consequently it sometimes happens that, long after the clinical symptoms have disappeared, and when the patient is apparently perfectly normal, examination of the throat reveals the presence of the bacillus; and it has been proved beyond question that germs from this source are often capable of transmitting the disease to healthy persons. It is a real hardship to such a patient to be kept in quarantine for days and weeks, until the disappearance of the germ in the throat is established by bacteriological examination, and boards of health are frequently criticized severely for enforcing quarantine under such circumstances; but it is obvious that these measures are demanded in the interests of the community and that resistance to them can arise only from ignorance or selfishness, or both.

4. What the public may do to protect and promote the health of the individual. On the other hand, the community, through its paid or unpaid officials, can do much to protect and promote the health of its individual members. It should see to it that the public water supply is pure; it should maintain an efficient system of milk inspection; it should provide investigations of food adulteration, and prosecutions and penalties for the same; it should require prompt and efficient scavenging, and the collection and removal of wastes such as sewage, garbage, and other refuse; it should establish a system of medical inspection of schools and of school hygiene; it should prevent the concealment of the existence of cases of infectious or contagious disease; it should provide for vaccination against smallpox, for the use of antitoxic serum in diphtheria, and for immunization against typhoid fever; it should provide laboratories for the rapid diagnosis of communicable diseases; and in many other ways it should protect the individual and his family even better than he, unaided, could protect himself. Finally, state boards of health may, by the publication and free distribution of popular health bulletins, bring to the attention of the people of the state those matters of health regarding which, from time to time, they need reliable and authoritative information. In New York, Virginia, and other states the intelligent coöperation of the people in the improvement of the public health has been greatly strengthened by such bulletins.

CHAPTER XXXVII

INTERNATIONAL HEALTH RELATIONS

1. The modern world one vast community. Ever since the invention of the mariner's compass, followed as this was by the voyages of discovery of Columbus, Vasco da Gama, and Magellan, the world has become, century by century, more and more one great community, or neighborhood. With the introduction of steam transportation on land and sea our globe has practically shrunk so that intercourse between the various nations of the earth has become both frequent and easy; and if there were no other means for the prevention of disease than those formerly known, plagues and pestilences would, without question, ravage mankind worse than ever before. The isolation of the ancient world gave it some sanitary protection, but to-day there is no isolation. Steamers ply regularly and frequently between Orient and Occident, commingling the people and the products of the whole world. Books, newspapers, letters, food materials, fabrics, and many other sorts of merchandise pass freely back and forth, and yet plague and pestilence to-day seldom follow in their train.

2. Ancient paths of pestilence and plague. Although modern civilization is indebted to the Orient for its first knowledge of the art of inoculation for the prevention of smallpox, it is no less true that many of its worst epidemic diseases have often come from the same source.

The plague, a world-famous disease (p. 518), has afflicted mankind for centuries, and has repeatedly appeared in Europe, traveling westward from the Orient and from Africa. The Black Death, which is held to have destroyed one fourth of the population of Europe in the fourteenth century, was probably a virulent form of the oriental plague which entered Europe from the south and east. The Great Plague of London (in 1665) probably came from Holland, in bales of merchandise brought from the Levant.

The Asiatic cholera, as its name suggests, has repeatedly come to Europe and America from the East, and is believed to exist almost constantly in India, from which place its germs are readily conveyed to western countries. The germs of the great Hamburg (Germany) epidemic of 1892 were probably brought there by immigrants from Russia.

3. The modern impotence of pestilence and plague. The modern increase of the means of communication has no doubt tended to spread far and wide all sorts of contagious and infectious diseases; but with that increase there has come, especially within the last few years, such a scientific knowledge of these diseases and of the ways of holding them in check that, in spite of vastly greater facilities for their distribution, they are actually less dangerous to mankind, and far less dreaded, than they formerly were. The appearance of the bubonic plague in China or in India, or of Asiatic cholera in Japan or in the Philippines, still causes international anxiety, and vigorous local precautionary or corrective measures are taken to overcome them; yet little widespread alarm is felt. The closer intimacy between Cuba and the United States since the Spanish War of 1898, while in itself favoring the spread of yellow fever, has had the marvelous and happy consequence (thanks to the brilliant researches and able administration of the medical and sanitary officers of the American army) not of bringing more yellow fever to the United States, as would formerly have been the case, but of virtually extirpating that disease, for the present at least, in Cuba.

4. The use and abuse of quarantine. The word "quarantine" comes from the French word *quarante*, meaning "forty," because a detention of forty days was formerly enforced upon travelers crossing frontiers. Quarantine is of great value in some cases, as, for example, in ports like Boston or New York, and, when thoroughly enforced, may be an important means of protecting a region against infectious disease. When a vessel which has been long enough at sea to give contagious disease (if present) time to appear, comes into port with cases of such disease on board, its detention is a wise precaution. On the other hand, indiscriminate quarantine between states or cities, or of vessels that have come from near ports, so that little or no time has been given for disease, if present, to show itself, is necessarily severe and often useless and unwarrantable.

Quarantine is also liable to abuse on other grounds, for it is claimed that it has sometimes been unjustifiably employed to keep out of a country foods or other products which came into competition with domestic products, the plea of sanitary danger being raised for commercial reasons.

5. International sanitary congresses. From time to time there are held nowadays international sanitary congresses which undertake to deal with the larger questions affecting the health of nations. There are also held from time to time international congresses of hygiene and demography, while the meetings of the American Public Health Association, in which the United States, Canada, Mexico, and Cuba are represented, are really international congresses for a large part of the western hemisphere.

6. Health and longevity in various countries. It is interesting to inquire how different nations compare, one with another, in respect to health and longevity. It might be supposed that somewhere on the earth's surface the climate would be so salubrious, the food so wholesome, the conditions so favorable, and life so normal, that sickness would be unknown and death indefinitely postponed. Invalids in large numbers do, in fact, turn to Colorado or California, to Madeira or to the Riviera, seeking in these places more favorable conditions for sustaining or prolonging life; but no place has ever been found altogether free from disease, and no climate, however salubrious, seems capable of causing any great increase in longevity. It was many centuries ago in the Orient, and of a race singularly strong and persistent, that the Hebrew poet wrote those majestic lines which for every land and every people are no less true to-day: "The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow; for it is soon cut off, and we fly away."

The general death rate (that is, the number of deaths per year per thousand of the population) is not a complete measure either of health or of longevity, but is sometimes the only test we have; and the following table for 1900 shows how great the difference may be in the death rates of some of the larger cities of the world.

London	18.7	Moscow	30.0
New York	20.6	Rome	16.5
Paris	20.5	Madrid	33.3
Berlin	18.9	Stockholm	17.1
Vienna	20.6	Boston	20.8
Petrograd	27.0		

The table on page 560 (from the United States Census of 1900) gives the death rates for the periods specified of some of the principal countries of the civilized world.

7. The sanitation of the world. Enough has been said in the foregoing pages to indicate that while the hopes of dreamers seeking after an elixir of life have no foundation, and while a wholly salubrious environment cannot greatly prolong human life beyond the usual period, much is being done, and much still remains to be done, for a more complete and perfect sanitation. Communicable diseases still sweep over communities, carrying sickness and death among the people, increasing the death rate, and diminishing longevity.

COMPARATIVE DEATH RATES PER 1000 POPULATION FOR CERTAIN COUNTRIES

	1890	Twenty-Five Years 1876–1900	1900
Austria	29.4	28.6	25.4
Belgium	20.6	20.1	19.3
Denmark	19.0	18.3	16.9
England and Wales	19.5	19.1	18.2
France	22.8	21.9	21.9
German Empire	24.4	24.2	22.1
Prussia	24.0	23.7	21.8
Hungary	32.4	32.3	26.9
Ireland	18.2	18.2	19.6
Italy	26.4	26.5	23.8
Netherlands	20.5	20.3	17.8
Norway	17.9	16.6	15.9
Scotland	19.7	19.2	18.5
Spain	32.5	30.3[1]	28.7
Sweden	17.1	17.0	16.8
Switzerland	20.8	20.6	19.3
United States (registration area)	19.6	——	17.8

[1] Average for twenty years, 1878–1884, 1888–1900.

Here and there nations and individuals are devoting themselves with energy, public spirit, and wisdom to investigation of the causes of disease, and to improvement of their environment by careful organization of boards of health, by municipal sanitation, by sanitary engineering, by purer water and milk supplies, by proper sewerage and sewage disposal, by food inspection, and the like. All this is wise and encouraging, but it is only a beginning. Far more might and ought to be done both by nations and by individuals. Many of the nations, especially those known as half-civilized or barbarous, have as yet hardly made a beginning in hygiene or sanitation; and as long as this is the case, they are, and will continue to be, a menace not only to themselves but to the whole world, which, as one vast community, is in these respects closely bound together. One of the most important movements of recent years is the establishment of the Rockefeller International Health Board, which undertakes, among other things, the improvement of unsanitary or unhygienic conditions among these half-civilized or backward peoples.

The student should never forget that the foundation of municipal, national, and international hygiene and sanitation, and therefore of the health of nations, rests ultimately upon the hygiene and sanitation of individuals, — that is, upon personal hygiene and sanitation. If all human beings were healthy and clean, the nations of the world would of necessity be in the same condition. Personal hygiene and scientific sanitation thus form the basis of all hygiene and sanitation, whether of home or village, of town or city, or of the world; and the essentials of personal hygiene and sanitation are simply the proper management and care of the human mechanism and its surroundings.

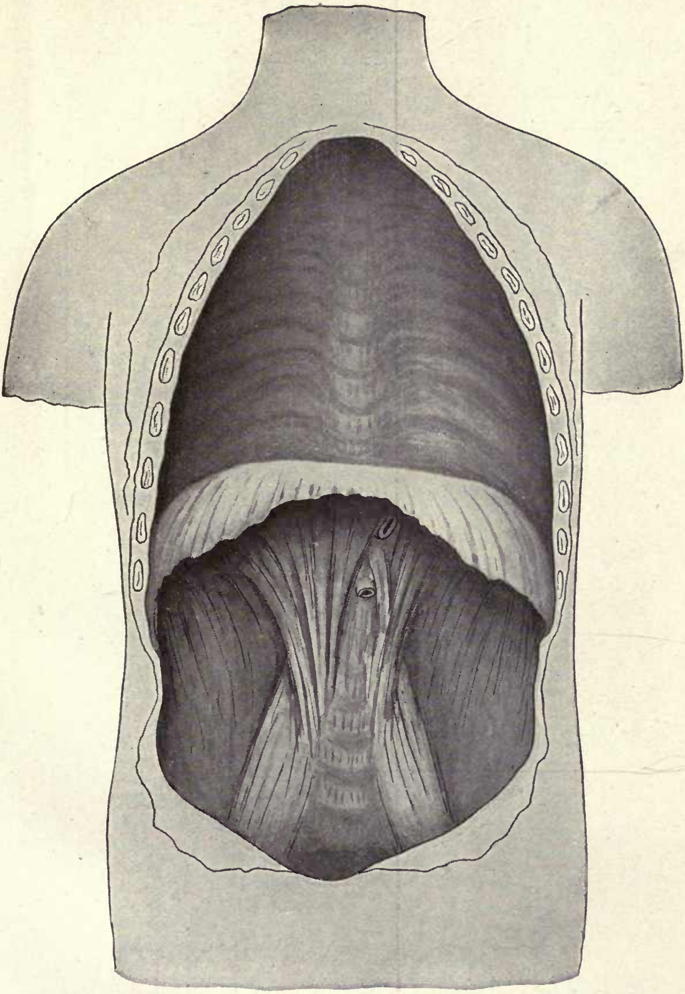


FIG. 154. The thoracic and abdominal cavities, after the removal of the organs shown in Fig. 2

The diaphragm has been drawn somewhat forward

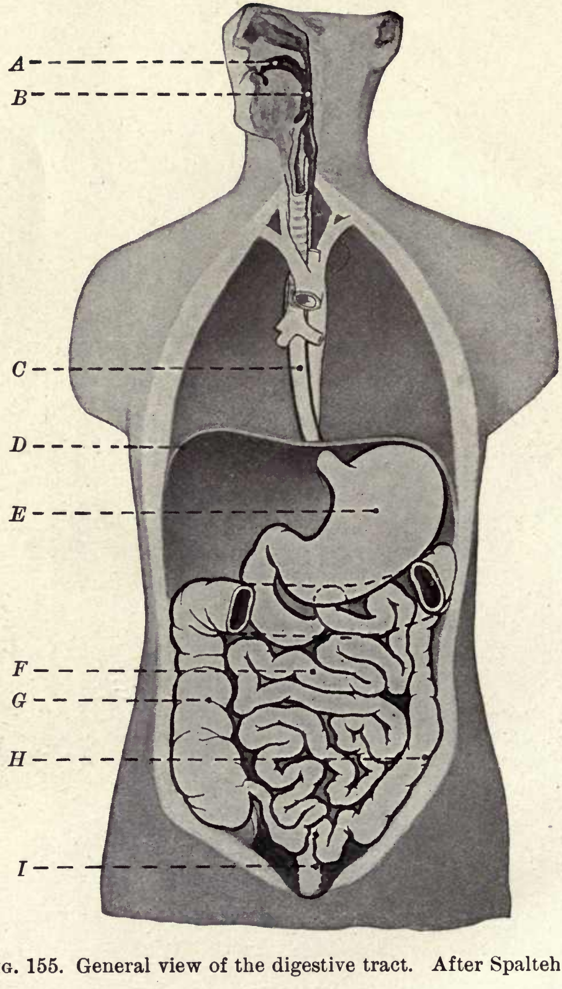


FIG. 155. General view of the digestive tract. After Spalteholz

A, mouth cavity; *B*, pharynx; *C*, œsophagus; *D*, diaphragm; *E*, stomach; *F*, small intestine; *G*, ascending colon; *H*, descending colon; *I*, rectum. The transverse colon has been cut away, its position being indicated by dotted lines

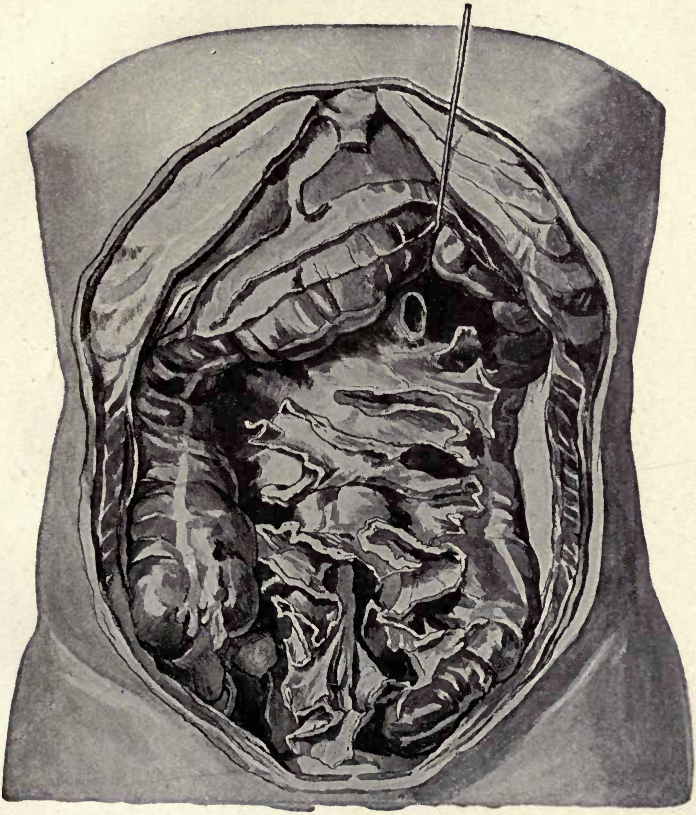


Fig. 156. The flouncelike folding of the mesentery, as seen after removing the small intestine. After Spalteholz

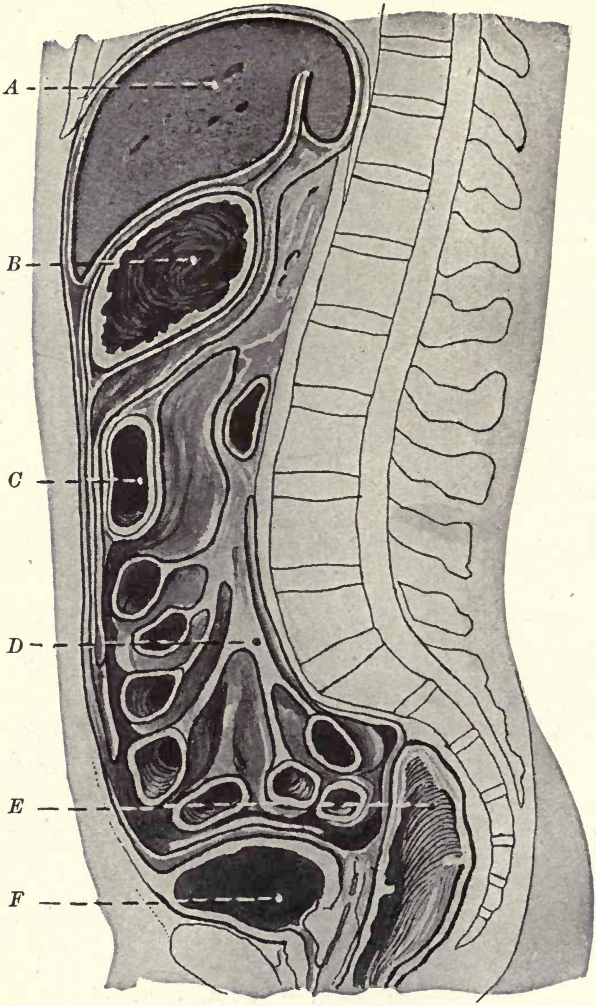


Fig. 157. Median dorso-ventral section of the trunk in the abdominal region, showing the suspension of the stomach and intestine by the mesentery. After Spalteholz

A, liver; *B*, stomach; *C*, transverse colon; *D*, mesentery; *E*, rectum; *F*, urinary bladder

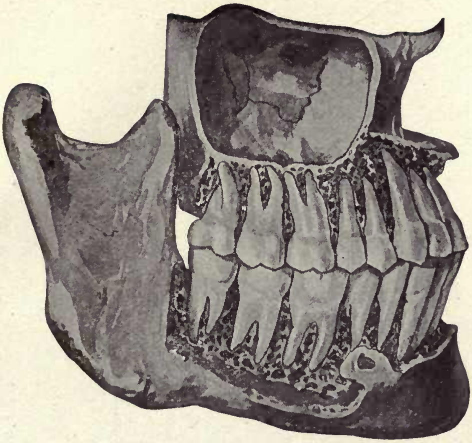


Fig. 158. The permanent teeth in the jaw-bones, viewed from the right. After Spalteholz

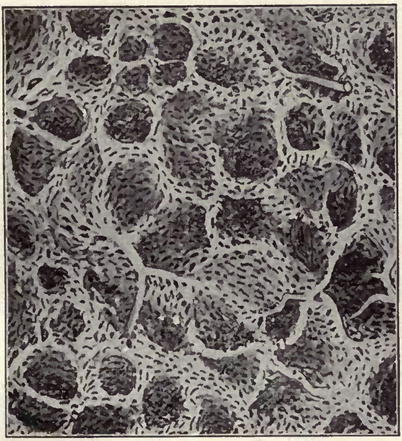


Fig. 159. The network of capillaries on the lining of the air cells of the lungs. After Kölliker

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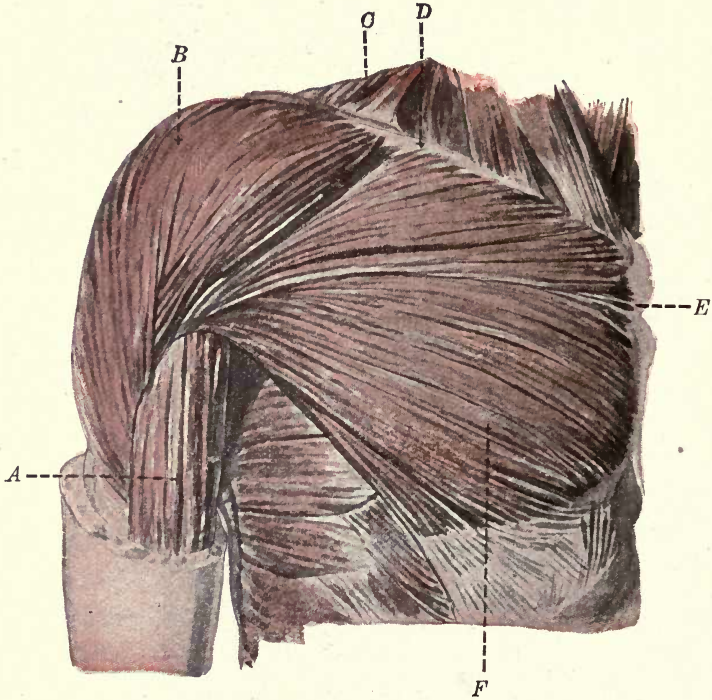


Fig. 160. First layer of muscles of the breast and shoulder region. After Spalteholz

A, biceps of the arm (p. 33); *B*, deltoid; *C*, portion of the trapezius (see Figs. 113 and 114); *D*, clavicle; *E*, sternum or breastbone; *F*, pectoralis major (see p. 316 and Fig. 114)

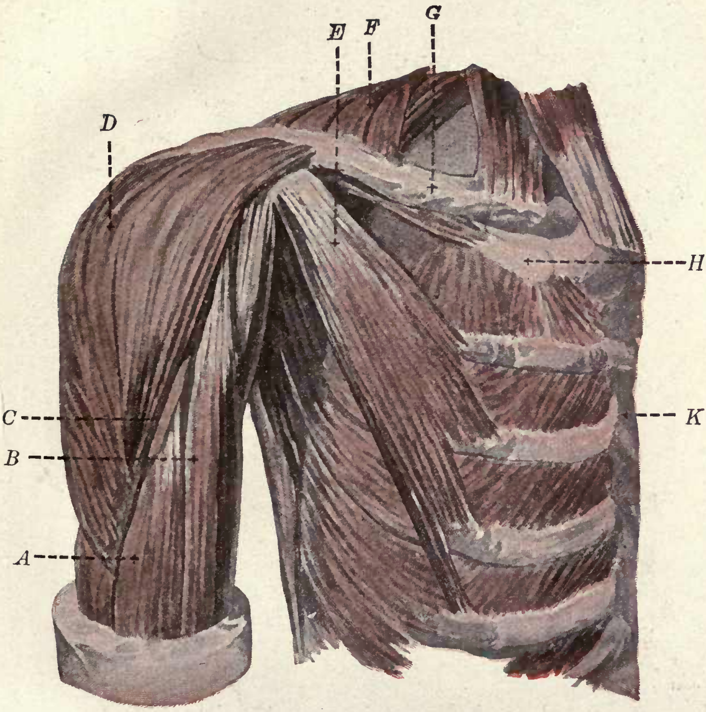


FIG. 161. Second layer of muscles of the breast, exposed by dissecting away the pectoralis major in Fig. 160. After Spalteholz

A, *B*, the two "heads" of the biceps; *C*, cut end of the pectoralis major; *D*, deltoid; *E*, pectoralis minor; *F*, trapezius; *G*, clavicle; *H*, first rib; *K*, sternum. Note the direct attachment of the intercostal muscles to the ribs (p. 8). Compare Fig. 160

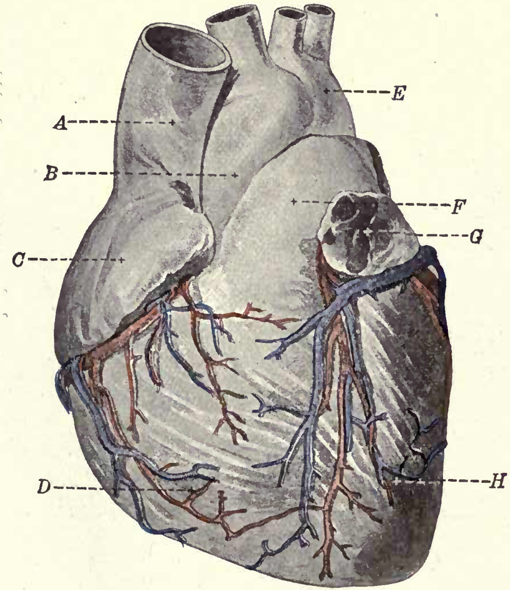


FIG. 162. Ventral aspect of the heart. After Spalteholz

A, superior vena cava; *B*, beginning of aorta; *C*, right auricle; *D*, right ventricle; *E*, arch of aorta; *F*, pulmonary artery; *G*, left auricle; *H*, left ventricle. Some of the chief arteries and veins of the heart are shown. The entrance of the pulmonary veins into the left auricle and that of the inferior vena cava into the right auricle are on the dorsal side of the heart and hence are not shown in the figure

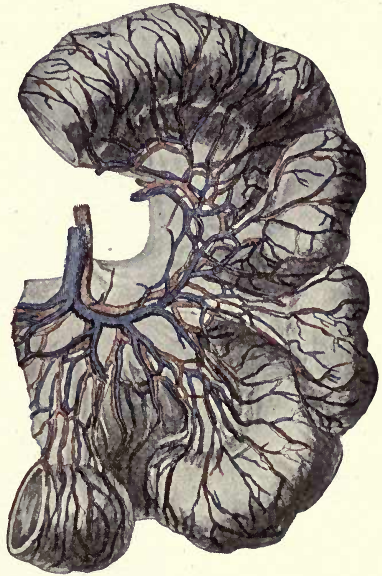


FIG. 163. A portion of the small intestine

Showing its attachment to the flouncelike mesentery, and the course of its arteries and veins in the mesentery (see p. 13). After Spalteholz

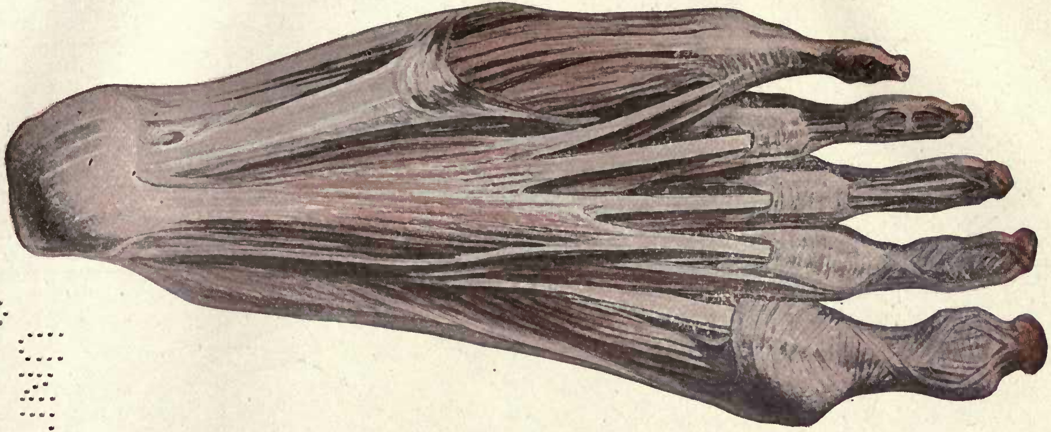
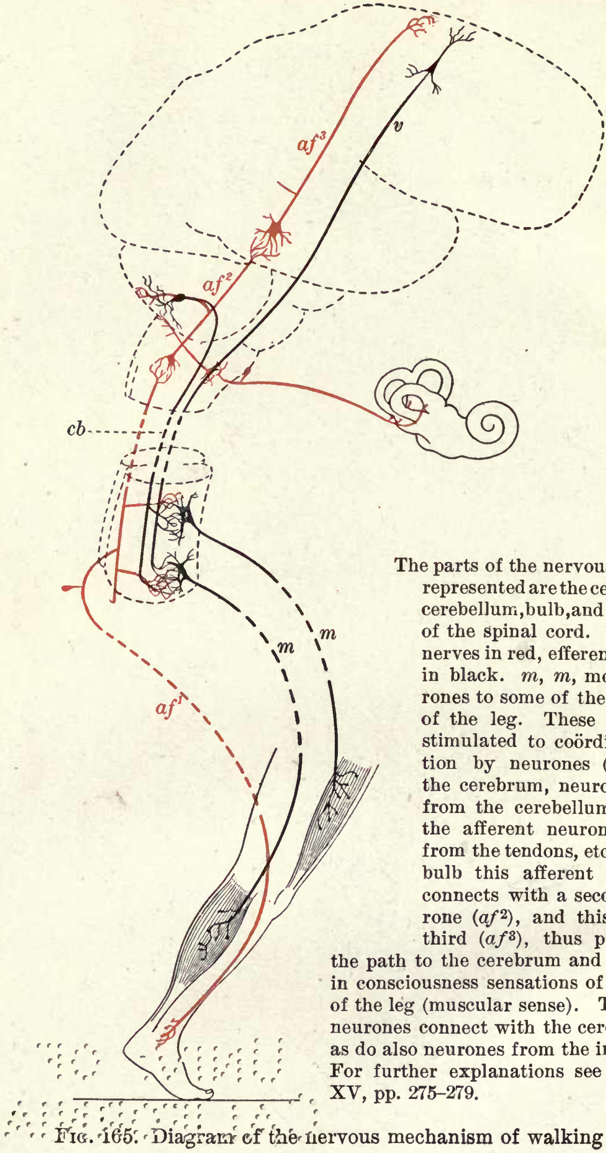


FIG. 164. Some of the muscles, tendons, and ligaments of the sole of the foot. After Spalteholz

Note the bowstring action of the muscles and tendons. For further description, see Chapter XXIV



The parts of the nervous system represented are the cerebrum, cerebellum, bulb, and segment of the spinal cord. Afferent nerves in red, efferent nerves in black. *m*, *m*, motor neurones to some of the muscles of the leg. These may be stimulated to coördinate action by neurones (*v*) from the cerebrum, neurones (*cb*) from the cerebellum, or by the afferent neurones (af^1) from the tendons, etc. In the bulb this afferent neurone connects with a second neurone (af^2), and this with a third (af^3), thus providing the path to the cerebrum and exciting in consciousness sensations of position of the leg (muscular sense). The same neurones connect with the cerebellum, as do also neurones from the inner ear. For further explanations see Chapter XV, pp. 275–279.

Fig. 165. Diagram of the nervous mechanism of walking

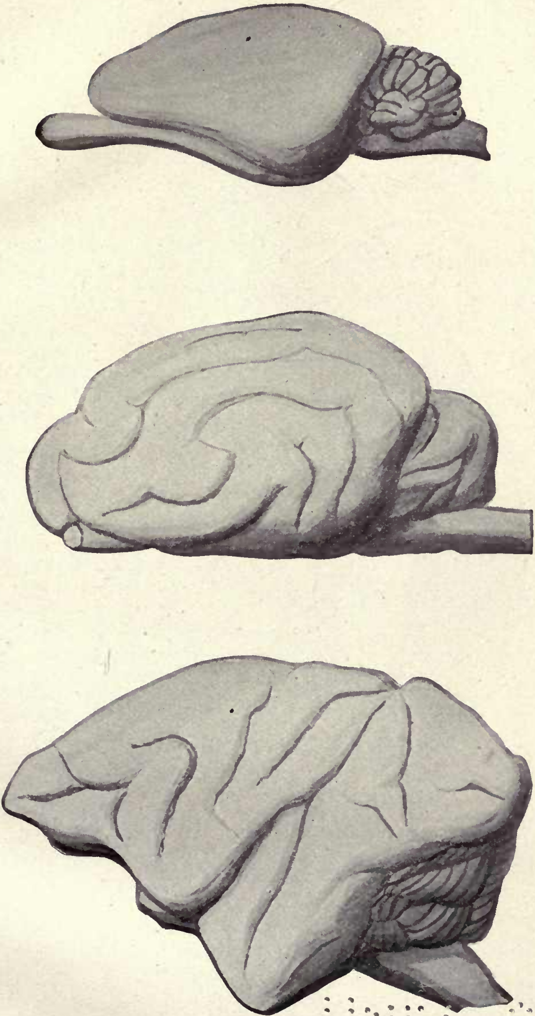


Fig. 166. Side view of the brains of rabbit, cat, and monkey.

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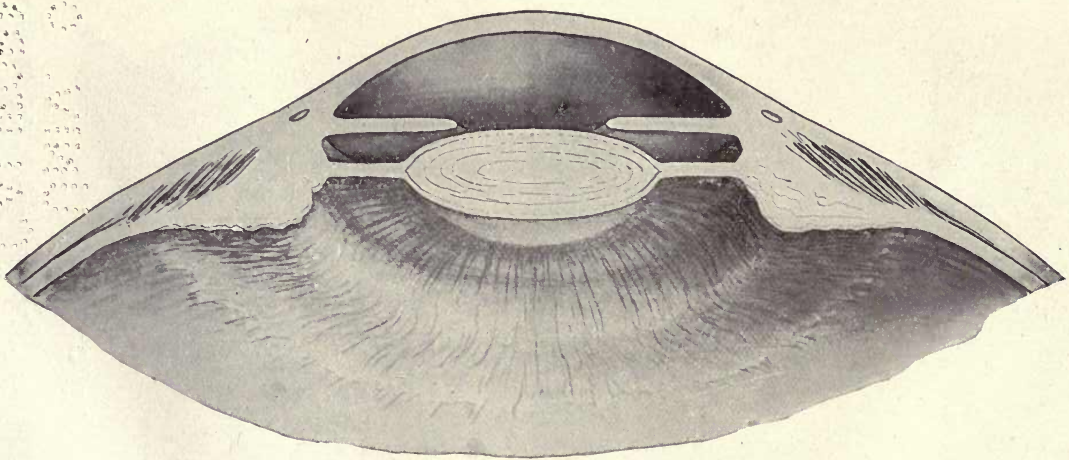

FIG. 167. Perspective view into the hemisphere of the eye

The names of the parts are given in Fig. 93, p. 244

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